THE CAPACITY OF MONTREAL LAKE, SK TO PROVIDE SAFE DRINKING WATER

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Abstract

Recent waterborne disease outbreaks in Canada have brought national awareness to drinking water safety. In particular, the long history of poor water quality plaguing First Nations communities has received substantial public attention. Despite several initiatives from the federal government and considerable financial support, the quality of drinking water on reserves has shown little improvement and continues to pose health risks. As a result, there is a growing interest in the ability of First Nations communities to effectively manage their drinking water resources. The purpose of this study was to assess the capacity of Montreal Lake, SK to provide its residents with safe drinking water, both now and into the future. This research employed a mixed methods approach in the examination of the community's water system and management practices. Data sources included individual interviews, a public workshop, documents and inspection reports, and water quality data. Water system capacity was considered in terms of financial, human resources, institutional, social/political, and technical dimensions. An analytical framework was developed through a literature review where each dimension of capacity was rated based on a series of indicators. It was determined that there are no serious deficiencies in the management of Montreal Lake's drinking water. However, a number of flaws in each aspect drinking water management were detected. These include weak linkages between the agencies responsible for drinking water provision, and a low level of drinking water safety for community residents served by the truck haul distribution system. This research confirms the multi-dimensional aspects of water system capacity, reveals the necessity for the different levels of authority to work together, and provides an analytical framework which may be applicable to future studies examining First Nations and small-scale drinking water systems.

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List of Acronyms

CAIS	Capital Asset Management System
CBWM	Community-based Drinking Water Quality Monitor
CRTP	Circuit Rider Training Program
DIAND	Department of Indian Affairs and Northern Development
DWSP-NP	Drinking Water Safety Program for Native People
EBWO	Emergency Boil Water Order
EHO	Environmental Health Officer
FNWMS	First Nations Water Management Strategy
GCDWQ	Guidelines for Canadian Drinking Water Quality
INAC	Indian and Northern Affairs Canada
MAC	Maximum Acceptable Concentration
PAGC	Prince Albert Grand Council
PDWA	Precautionary Drinking Water Advisory
PWGSC	Public Works and Government Services Canada
SDWA	Safe Drinking Water Act
WQT	Water Quality Technician

1.0 Introduction

1.1 Statement of Problem

Water has long been undervalued in Canada. It is often perceived as a limitless resource and Canadians are amongst the highest per capita water users in the world (Shrubsole and Draper, 2006). The misconception of freshwater abundance has contributed to thoughtless management practices, which combined with climate change, have lead to the forecast that freshwaters will become Canada's foremost ecological crisis in the near future (Sprague, 2006; Schindler, 2001). The vital importance of water to all life is motivation for wise management (Shortt et al., 2006; Vigil, 2003). In recent years, Canadians have become more conscious of the water issues facing their country (Bakker, 2006). This is illustrated by the publication of *Eau Canada: The Future of Canada's Water*, a book intended to be read by the general public focused on pressing water concerns. Although there are many water issues across the nation, none resonates with Canadians as strongly and homogeneously as unsafe drinking water (Dupont, 2005).

The public perception of drinking water safety in Canada was shaken by the waterborne disease outbreaks in Walkerton, Ontario in 2000, and North Battleford, Saskatchewan in 2001 (Dupont, 2005; Hrudey, 2004). The outbreaks received unprecedented publicity which alerted Canadians to the public health issues related to water quality (Bakker, 2006; Hrudey and Hrudey, 2002). However, for a large group of Canadians, the hazards of poor water quality had been a part of everyday life long before the tragedy in Walkerton (Wilson, 2004). First Nations communities across Canada have a long history of unsafe drinking water continually threatening the health of residents (Expert Panel, 2006; Office of the Auditor General, 2005; Wilson, 2004; NAHO, 2002; O'Connor, 2002). Data from 2006 and 2007 indicate that over 10% of these communities are under boil water advisories at any given time (Health Canada, 2007a; Graham and Fortier, 2006). Nevertheless, it took another water contamination incident, this time in the First Nations community of Kashechewan, Ontario in 2005, to move the national spotlight to the plight of drinking water quality on reserves.

The Government of Canada has a clear mandate and fiduciary responsibility to ensure safe drinking for First Nations communities (Morris et al., 2007). The departments of Indian and Northern Affairs Canada (INAC) and Health Canada are responsible for financing and ensuring the adequacy of capital construction and upgrading, operation and maintenance, monitoring, and operator training of water systems on reserves (INAC, 2004a). For more than a decade, the federal government has spent considerable funds trying to address the prevalence of unsafe drinking water without generating many improvements (Office of the Auditor General, 2005). Previous research has revealed a number of challenges First Nations communities face in the provision of drinking water including small size, remote location, poor economic conditions, and rapidly growing populations (Expert Panel, 2006; Smith et al., 2006; Office of the Auditor General, 2005).

In First Nations communities like in the rest of Canada, the failure to provide clean water cannot be explained by lack of scientific understanding (de Loë and Kreutzwiser, 2005; Hrudey and Hrudey, 2004). Instead, inadequate drinking water management appears to be the most important factor accounting for poor public water supplies and outbreaks of waterborne diseases (de Loë and Kreutzwiser, 2005). Deficiencies in First Nations drinking water management include funding shortfalls, lack of certified operators, absence of a regulatory regime, management complexity, and inadequate infrastructure (Expert Panel, 2006; Office of the Auditor General, 2005; INAC 2003; O'Connor, 2002). These problems work together to reduce water system capacity - the ability to plan for, achieve, and maintain compliance with safe drinking water standards (de Loë and Kreutzwiser, 2005; USEPA, 1998).

The concept of capacity, the ability to plan for, achieve, and maintain compliance with applicable drinking water standards (USEPA, 1998), has been used in water management studies since the early 1990s (e.g., Hartvelt and Okun, 1991) but was not popularized with regard to drinking water provision until the 1996 amendments to the US Safe Drinking Water Act (Soelter and Miller, 1999). Since then, a considerable amount of capacity research has been conducted in areas ranging from source water protection (e.g., Timmer et al., 2007), groundwater protection (e.g., de Loë and Kreutzwiser, 2005; de Loë and Lukovich, 2004; de Loë et al., 2002), water shortages (e.g., Ivey et at., 2004; Pirie et al., 2004; de Loë et al., 2001), and the capabilities of small water systems (Brown et al., 2005; Dziegielewski and Bik, 2004; Flora, 2004; Maras, 2004; Soelter and Miller, 1999). Framing research using the concept of capacity is logical because it allows the consideration of several interrelated dimensions that are critical in the management of water resources (Ivey et al., 2004).

Although many studies have adopted the capacity approach to consider drinking water management, they relate very little to First Nations communities. To date, the majority of research has focused on a range of municipalities in Ontario and eastern Canada, and small communities in the United States. First Nations water systems are faced with unique challenges that significantly influence their ability to produce safe drinking water (Expert Panel, 2006). Therefore, although the conceptual approach of capacity is applicable in an examination of drinking water management in these communities, the characteristics of the dimensions that interact to make water system capacity are relatively unknown.

Few academic studies have considered any aspect of drinking water management in First Nations communities in Canada. The one major exception is Smith et al. (2006), who evaluated the ability of fifty-six drinking water systems on First Nations reserves in Alberta to protect public health. The research by Smith et al. (2006) provides a thorough reference point to some of the technical and human resources deficiencies present in First Nations water systems. However, the financial, institutional, and social/political considerations that also influence the provision of safe drinking water were not investigated. The lack of research on and knowledge of First Nations drinking water management is surprising when the long history of unsafe drinking water quality in these communities is considered.

The Walkerton tragedy demonstrated that the consequences of insufficient water system capacity can be tragic (de Loë et al., 2002). It is clear that the capacity of First Nations communities is poorly understood. These factors together with the growing interest in the capacity of communities to manage their water resources among both the academic field and professional practitioners provide the rationale for investigating water system capacity in a First Nations community (Ivey et al., 2004).

1.2 Purpose and Objectives

The purpose of this study is to assess the capacity of Montreal Lake, Saskatchewan (SK) to provide its residents with safe drinking water, both now and into the future. The objectives of the research are:

(1) Develop a framework that permits the consideration of capacity in the context of First Nations drinking water management

(2) Gain an understanding of the capacity to manage water resources in Montreal Lake, SK

(3) Broaden awareness of the challenges faced by First Nations communities in the provision of safe drinking water

By fulfilling the research objectives, the ultimate goal of this study is to provide the community of Montreal Lake with information that may improve drinking water safety. In addition, as drinking water management in First Nations communities is poorly understood, I hope that the framework and results of this study will make a contribution to the knowledge base.

1.3 Study Area

This study was conducted in the First Nations community of Montreal Lake (Figure 1.1), located in north-central Saskatchewan (54° 4’59’’ N 105° 49’0” W) within

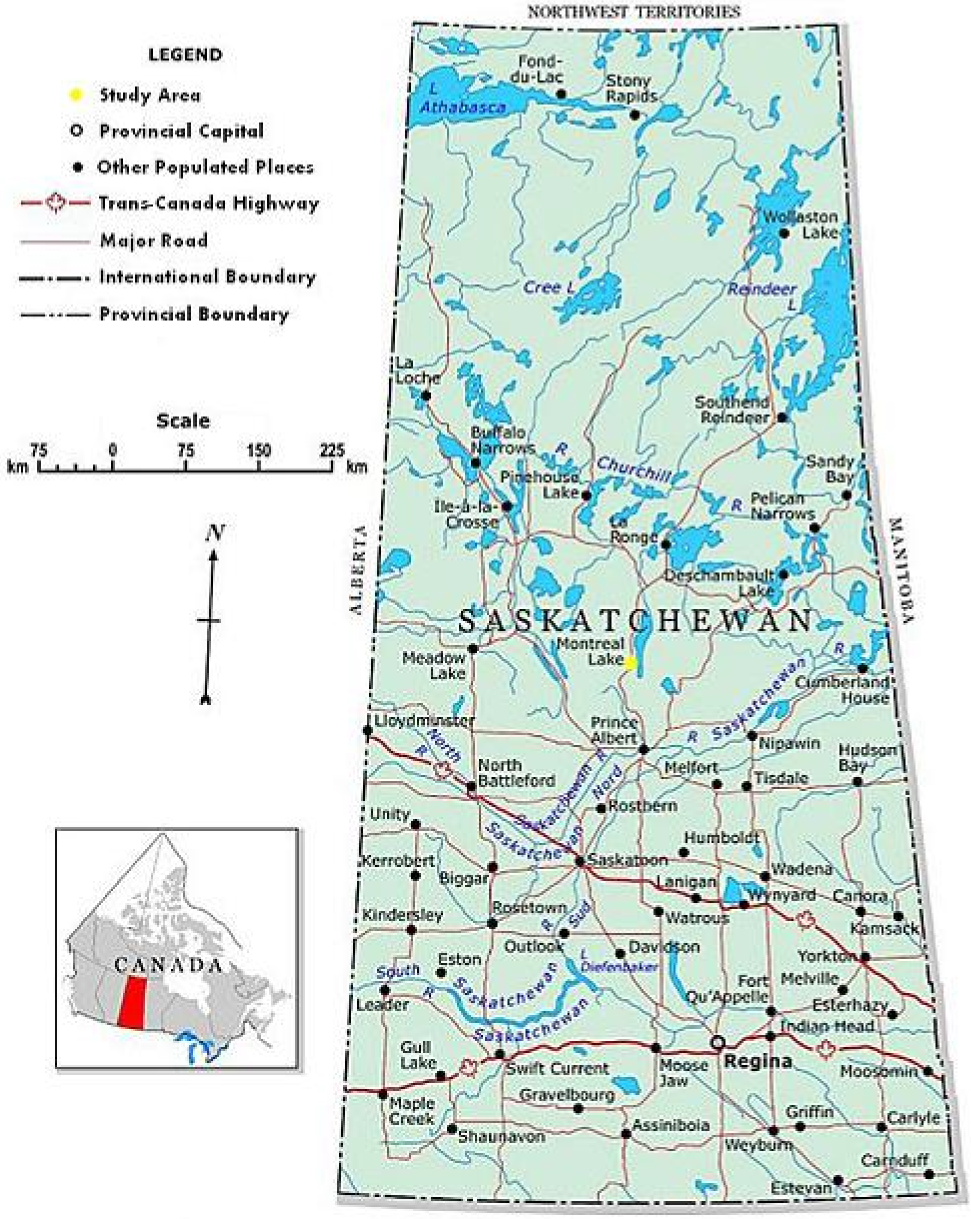

Figure 1.1 Geographic Location of Montreal Lake
Modified from: Natural Resources Canada. 2001. Saskatchewan Map [Online]. http://atlas.nrcan.gc.ca/site/english/maps/reference/provincesterritories/saskatchewan/map.pdf. Accessed 25-February-2008.

the southern boreal forest. Montreal Lake has been described as a non-traditional forest-dependent community, in the sense that the majority of jobs are found in other sectors (Parkins et al., 2001). However, the community remains strongly tied to the forest for lifestyle and non-industrial uses. It should be noted that there are two reserves set aside for members of the Montreal Lake Cree Nation. The community of Montreal Lake identified in Figure 1.1 is located on Montreal Lake Indian Reserve #106. The second reserve, officially Montreal Lake Indian Reserve #106B but known as the Little Red Reserve, is located approximately 40 km south. This study pertains only to the community of Montreal Lake situated on Indian Reserve #106. A detailed profile of the community is provided in section 3.1.

1.4 Thesis Overview

This thesis describes in six chapters the capacity of Montreal Lake, SK to provide safe drinking water. Chapter 2 continues with a review of the literature that provided the context of this study. The bodies of literature that were examined focus on drinking water quality in First Nations communities, deficiencies in First Nations drinking water management, capacity, and the challenges small systems and First Nations water systems face in the achievement of capacity. Chapter 3 provides an in-depth profile of Montreal Lake's drinking water system. An understanding of a community's drinking water system characteristics is critical in the assessment of its ability to produce safe drinking water. Chapter 4 describes the methodology that was used in this study, including the details of the evaluative framework. Chapter 5 focuses on the evaluation of water system capacity.

Financial, human resources, institutional, social/political, and technical dimensions are examined individually in the context of Montreal Lake. The thesis comes to a close in Chapter 6 where a summary of findings, implications, and lessons learned are discussed.

2.0 Literature Review

2.1 Drinking Water in First Nations Communities

Safe drinking water may be a community's most valuable resource. The protection of public health and the promotion of development both rely on the provision of fresh clean drinking water (Davies and Mazumder, 2003; Page, 2001). Canada is home to 7% of the world's renewal freshwater resources (Environment Canada, 2006a), which places the majority of its communities in a favourable position to provide their residents with reliable and safe drinking water. As a result, Canadians are generally accustomed to an easily accessible and seemingly endless supply of clean drinking water, which has had the negative consequences of the resource being often undervalued and underappreciated (Brandes and Kriwoken, 2006; McQuigge, 2002). However, the Walkerton tragedy of 2000 (where 2,300 individuals became ill and 7 died as a result of contaminated drinking water) and the North Battleford outbreak of 2001 (where 5,800–7,100 individuals became ill), transformed the perception of waterborne disease and drinking water safety into one of Canada's most pressing health issues. Public concern and awareness of drinking water safety has consequently increased throughout the country and has stimulated considerable research (Christensen, 2006; Turgeon et al., 2004; Christensen, 2001).

Surprisingly, water quality issues and waterborne disease outbreaks have not been uncommon within Canada (Schuster, 2005; Charron et al., 2004; Hrudey and Hrudey 2004) but have only recently begun to receive widespread national attention. This is clearly evident in the case of First Nations communities, as it was not until the water problems at the Kashechewan reserve were revealed in late 2005 that the public became aware of the long history of unsafe drinking water in these communities across Canada.

The poor quality of drinking water in First Nations communities was identified at least as early as 1990 (Moore, 1999), and continues to be a serious health and safety issue for residents (Office of the Auditor General, 2005; INAC, 2004b; Wilson, 2004; INAC, 2003; Parsons, 2003; NAHO, 2002; O'Connor, 2002). Across the nation, First Nations communities have experienced outbreaks of shigella, Hepatitis A, diarrhoea, and isolated cases of mild cholera caused by *Escherichia coli* (*E. coli*), giardia, and cryptosporidium (Wilson, 2004). Microbiological contamination of drinking water is a constant challenge for residents of reserves. Of the more than 700 First Nations communities across Canada, 99 were under a drinking water advisory during the week of October 19, 2007 (Health Canada, 2007a). Table 2.1 displays the number of First Nations communities across Canada under a drinking water advisory over the course of one year (October 6, 2006 – October 19, 2007), illustrating that at any given time the threat of unsafe drinking water is faced by approximately 1/7 of all First Nations communities in the country.

The federal government has a fiduciary responsibility to ensure that First Nations communities have a clean and reliable source of drinking water (Morris et al., 2007; Chiefs of Ontario, 2001), and although significant quality issues remain, the provision of clean, safe and secure drinking water has been identified as a top priority for the Government of Canada (INAC, 2004b). For more than a decade, the federal government

Table 2.1 Number of First Nations Communities with a Drinking Water Advisory (October 6, 2006 – October 19, 2007)

Year	Week Ending	Number of First Nations Communities with a DWA	Year	Week Ending	Number of First Nations Communities with a DWA
2006	Oct 6	87	2007	Apr 20	91
	Oct 13	87		Apr 27	92
	Oct 20	87		May 4	91
	Oct 27	88		May 11	90
	Nov 3	87		May 18	91
	Nov 10	83		May 25	90
	Nov 17	96		Jun 1	90
	Nov 24	96		Jun 8	89
	Dec 1	89		Jun 15	92
	Dec 8	86		Jun 22	90
	Dec 15	90		Jun 29	91
	Dec 22	87		Jul 6	91
	Dec 29	89		Jul 13	93
2007	Jan 5	89		Jul 20	97
	Jan 12	91		Jul 27	99
	Jan 19	90		Aug 3	101
	Jan 26	90		Aug 10	96
	Feb 2	87		Aug 17	96
	Feb 9	87		Aug 24	99
	Feb 16	88		Aug 31	97
	Feb 23	89		Sep 7	100
	Mar 2	87		Sep 14	100
	Mar 9	89		Sep 21	97
	Mar 16	93		Sep 28	102
	Mar 23	92		Oct 5	102
	Mar 30	94		Oct 12	103
	Apr 6	91		Oct 19	99
	Apr 13	91			

Note: Data provided by Health Canada on December 5, 2007.

has spent considerable funds researching and addressing the situation, but unfortunately these initiatives have yielded little improvement (Office of the Auditor General, 2005). These efforts include the 1990/91 Drinking Water Safety Program for Native People (DWSP-NP); the 1995 National Assessment of Drinking Water and Sewage Treatment in First Nations Communities; the 2001 National Assessment of Water and Wastewater

Systems in First Nations Communities; the 2003 First Nations Water Management Strategy; and the 2006 Plan of Action for Safe Drinking Water in First Nations Communities.

The $25 million DWSP-NP was introduced in 1990-91 for monitoring, training, technical advice, and local capacity-building (Health Canada, 2005a). The four primary objectives of the program were to (1) increase sampling and analysis of existing drinking water supplies for chemical and bacteriological quality, (2) provide advice to First Nations and the Department of Indian Affairs and Northern Development (DIAND) on the design, maintenance and operation of community water systems, (3) develop a training package for First Nations water and wastewater treatment plant operators, and (4) promote the importance of having a potable water supply through various educational media (Moore, 1999).

In 1995, after five years of implementing the DWSP-NP program, a national assessment of community drinking water systems and sewage treatment systems in First Nations communities across Canada was jointly conducted by Health Canada and the DIAND (Office of the Auditor General, 2005; Moore, 1999). The assessment was based on available data on the quality of drinking water (Office of the Auditor General, 2005) and determined that about 25% of the 863 community drinking water systems posed potential health and safety risks to the people they served based on bacteriological and/or chemical results from water samples as well as the condition of the systems themselves (Moore, 1999).

Another national assessment of water and wastewater systems in First Nations communities was conducted by Indian and Northern Affairs Canada (INAC) in 2001. This assessment was based on an on-site inspection of all on-reserve water systems and focused on system performance, associated risk levels and operating practices (INAC, 2003). Of the 740 community water systems assessed, 46% were considered to pose medium water quality risks, while 29% were classified as posing potentially high risks. Reasons for systems being considered as posing high or medium water quality risks include failure to meet one or more Maximum Acceptable Concentration (MAC) parameters, lack of operator knowledge to run the water system, a poor raw water source, inadequate treatment in place, lack of regular testing procedures and maintenance records, equipment failure, absence of backup equipment or power sources, and the lack of emergency procedures, safety equipment and operating manuals in the facilities (INAC, 2003).

In response to the 2001 assessment where only 25% of the water systems on reserves posed little or no risk to water quality issues (INAC, 2003), the federal government introduced the seven-part First Nations Water Management Strategy (FNWMS) in 2003. The FNWMS budget of $600 million over five years is intended to improve water and wastewater services on reserves in order to ensure the safety and well-being of First Nation community residents (Office of the Auditor General, 2005; INAC, 2004b). This initiative was jointly developed by INAC and Health and uses a multi-barrier approach to address water quality management. The seven elements involved in this strategy are: (1) building and upgrading water and wastewater facilities to meet established design, construction and water quality standards, (2) effectively operating and maintaining water and wastewater systems to ensure the safety of the residents and the protection of the assets, (3) enhancing the training and certification programs for operators, (4) launching a public awareness campaign aimed at informing on-reserve residents and First Nation decision makers of drinking water issues, roles and responsibilities, and protection measures, (5) a set of integrated water quality management protocols with clearly defined roles and responsibilities (6) establishing a comprehensive set of national standards, protocols, guidelines, and policies, and (7) an effective water quality monitoring program as per the *Guidelines for Canadian Drinking Water Quality* (INAC, 2006a; Office of the Auditor General, 2005; INAC, 2004a; INAC, 2004b).

Shortly after the FNWMS's initiation, the Office of the Auditor General (2005) conducted an audit to determine how well the strategy was being implemented and to what extent the programs and funding had helped in the provision of drinking water to First Nations communities comparable with that of other communities of a similar size and location. The report concluded that residents of First Nations communities do not benefit from a level of drinking water protection comparable to that of people living off reserves, and that this was due, in part, to the lack of laws and regulations governing the provision of drinking water in these communities. Furthermore, the Office of the Auditor General (2005) determined that despite the hundreds of millions in funds invested, a significant proportion of drinking water systems in First Nations communities continue to deliver water whose quality is at risk. Soon after the release of this report, the community of Kashechewan, in northern Ontario, was evacuated due to water quality concerns, bringing more attention to the situation in many First Nations communities. In response to these issues and the nationwide pressures to increase drinking water safety, the federal government announced another plan of action in March of 2006 to address the longstanding issue of poor water quality in First Nations communities.

The 2006 Plan of Action for Safe Drinking Water in First Nations Communities included five elements: (1) the implementation of the INAC (2006a) *Protocol for Safe Drinking Water for First Nations Communities*, covering a number of standards and requirements for drinking water systems, (2) mandatory training for all treatment plant operators through various initiatives and a regime to ensure that all systems are overseen by certified operators, (3) complete specific remedial plans for communities with serious water issues and high risks, (4) the establishment of the Expert Panel on Safe Drinking Water for First Nations (hereafter referred to as the Expert Panel) to investigate the appropriate regulatory framework options, including new legislation as a means of ensuring water quality, and (5) a clear commitment to report on progress on a regular basis (Expert Panel, 2006). Since the declaration of the action plan, INAC has published two progress reports on their website (http://www.ainc-inac.gc.ca/H2O/index_e.html) outlining the improvements that have been made. In particular, INAC (2007a) noted that (1) the *Protocol for Safe Drinking Water for First Nations Communities* has been put into effect, (2) all operators now have access to 24-hour support hotlines, while 875 of them have received on-going training through the Circuit Rider Training Program (CRTP), and

(3) the number of high-risk drinking water systems has decreased from 193 to 97. The Expert Panel (2006) has also published their report, offering three options for the implementation of drinking water legislation in First Nations communities.

2.2 First Nations Drinking Water Management

The management responsibility of water supplies from source to tap in First Nations communities is shared between First Nations and the federal government. Within the First Nations sphere, three authorities (Chief and Council, technical services advisory groups, tribal councils) are involved in the provision of drinking water (Expert Panel, 2006). The Chief and Council are generally responsible for the governance and maintenance of water systems, including the day-to-day operations such as sampling and testing drinking water. They must also make certain that the water systems are planned, designed, and constructed according to funding agreement conditions (INAC, 2004a). In some cases, technical service advisory groups are responsible for training and preparing operators for certification exams, and providing them with advice on site (Expert Panel, 2006). Lastly, tribal councils may be involved in water monitoring programs in the larger scope of public health matters and the technical support available for the planning, design, construction, and operation and maintenance of community infrastructure (Expert Panel, 2006; Office of the Auditor General, 2005). Although they may not be involved in management activities, First Nations water treatment plant operators are critical in the delivery of safe drinking water (Expert Panel, 2006; O'Connor, 2002).

Within the federal government, four departments play a role in providing First Nations communities with safe drinking water. INAC provides funding for capital construction and upgrading, operation and maintenance, and water and wastewater plant operator training and certification under the department's Capital Facilities and Maintenance Program. Funding is available for water systems that service five or more connections and covers the cost of all system components including treatment plants, intakes, trucked water, and storage reservoirs (INAC, 2004a). The program covers the full costs of design, construction, acquisition, upgrading, and major repairs for water services to residential and community buildings. INAC also provides funding for 80 percent of the estimated operation and maintenance costs for a particular water system, or will cover 80 percent of the costs when a First Nation buys its drinking water from a neighbouring municipality (INAC, 2004a). First Nations are expected to collect the remaining 20 percent through user fees or other sources (Office of the Auditor General, 2005). INAC also enforces certain standards, such as financial and project delivery performance, through funding agreements (Expert Panel, 2006) and subsidizes tribal councils to make technical support available for the planning, design, construction, and operation and maintenance of community infrastructure (Office of the Auditor General, 2005).

Health Canada provides environmental health services to First Nations communities south of 60 degrees parallel through the Environmental Health Program and the Drinking Water Safety Program (Health Canada, 2007a; INAC, 2004a). This involves the funding and delivery of drinking water monitoring programs. In certain communities, Health Canada employees test drinking water directly, while in others monitoring responsibilities have been completely transferred to First Nations (Office of the Auditor General, 2005). Where transfer programs are in place, Health Canada's role is to support and train community-based drinking water monitors (INAC 2004a). Health Canada (1996) also publishes and regularly updates the *Guidelines for Canadian Drinking Water Quality* GCDWQ), which are used as the basis water quality sampling, testing, interpretations, objectives, and regulations.

Public Works and Government Services Canada (PWGSC) provides engineering advice and approvals on water and wastewater systems to INAC under a memorandum of understanding (INAC, 2004a). Lastly, Environment Canada is involved in source water protection which includes regulating wastewater discharge into federal water and the development of standards, guidelines and protocols for wastewater systems on Aboriginal lands (Expert Panel, 2006; INAC 2004a).

In summary, First Nations are generally responsible for ensuring that water systems are designed, constructed, maintained and operated according to appropriate standards, while the federal government has a fiduciary responsibility to make certain that the systems and financing are in place. However, as noted by the Office of the Auditor General (2005) and evident above, the federal government's fiduciary responsibility and practice of delineating day-to-day duties to First Nations creates an environment where it is not clear who is ultimately accountable for safe drinking water.

2.3 Common Deficiencies in First Nations Drinking Water Management

Unsafe drinking water in First Nations communities has many origins. Many researchers consider the complex jurisdictional framework that was alluded to in the previous section a key issue (Expert Panel, 2006; Office of the Auditor General, 2005; NAHO, 2002). Others point to observable flaws in drinking water systems, such as inappropriate water sources (INAC, 2003). There is also the widespread consensus that the federal government has failed to fulfill its fiduciary responsibility to ensure safe drinking water for Aboriginal Canadians (Christensen, 2006; Office of the Auditor General, 2005). The following segment introduces some of the deficiencies that are repeatedly identified in First Nations drinking water management.

The relationships within and among the departments of the federal government and, at times, different First Nations authorities, add to the complexity of providing safe drinking water. The involvement of so many different players often leads to a lack of clear authority in many areas (Expert Panel, 2006; Office of the Auditor General, 2005; Graham, 2002). Poor communication among the agencies further compounds drinking water safety concerns (Peterson, 2006). There are public documents in circulation outlining the agreed responsibilities of the key federal departments and those of water treatment plant operators, Chief and Council, and tribal councils such as *First Nations Water Management Strategy – Water and Wastewater Services on First Nation Reserves: Roles and Responsibilities* and the revised *Protocol for Safe Drinking Water in First Nations Communities*. However, with the presence of differing authorities, it is possible to imagine that they may have different, even diverging interests (Expert Panel, 2006). Furthermore, many duties of federal agencies, such as the provision of technical support to First Nations, are fragmented and not performed consistently (Office of the Auditor General, 2005). Management problems associated with the presence of multiple institutions are common in the water sector (Hamdy et al., 1998).

The safety of water systems in First Nations communities was thoroughly examined in an on-site assessment conducted by INAC in 2001. Of the 740 community water systems inspected, only 25 percent (185) were classified as posing essentially low or no risk to water quality. Two of the main reasons behind the high risk level associated with First Nations drinking water systems are poor quantity and quality of source water, and inadequate design and construction (Office of the Auditor General, 2005; INAC, 2003; Moore, 1999). O'Connor (2002) and the Expert Panel (2006) noted that water system infrastructure in First Nations communities is either entirely absent, obsolete, inappropriate, or of low quality. Furthermore, monitoring of drinking water quality produced by First Nations water systems has also been described as inadequate (Smith et al., 2006; INAC, 2003; Graham, 2002; O'Connor, 2002). The absence of diligent monitoring places First Nations communities at risk and allows an extended amount of time to pass before contamination of a water supply is detected (Smith et al., 2006).

Water system operators play a critical role in the provision of safe drinking water (Expert Panel, 2006; INAC, 2003; O'Connor, 2002). First Nations communities generally lack operators that are certified or qualified to operate their water treatment plants which places public health at risk (Smith et al., 2006; INAC, 2003). This is illustrated by a 2001 on-site assessment of water and wastewater systems in First Nations communities, where INAC (2003) determined that only 10 percent of operators met industry certification requirements. The results of the assessment persuaded INAC and Health Canada to make training and certification of operators one of the seven primary elements of the FNWMS (Office of the Auditor General, 2005; INAC, 2004a). In recent years, progress has been made on the provision of training to First Nations operators through the CRTP (INAC, 2007a; Smith et al., 2006), but it is still not adequate to provide as much help as operators would like (Expert Panel, 2006; Office of the Auditor General, 2005).

In terms of funding, First Nations communities appear at first glance to have adequate support from the federal government to construct, maintain and operate their drinking water systems. INAC and Health Canada completely finance design, capital construction and upgrading, major repairs, and monitoring, and cover 80 percent of the ongoing operation and maintenance costs. In addition, the federal government has allocated millions in additional funding in recent years towards improving drinking water safety in First Nations communities. This leaves 20 percent of the daily operation and maintenance costs in the hands of First Nations. However, operation and maintenance funding is based on a formula that is not calculated consistently across the country (Expert Panel, 2006; Office of the Auditor General, 2005). Finding funds to cover their portion of operation and maintenance funding is a serious hardship for many First Nations that is often ignored by INAC (Expert Panel, 2006; Office of the Auditor General, 2005). In addition to the inadequacy of financial resources to operate and maintain water systems, the Expert Panel (2006) discovered long waiting lists for capital funding. Despite the announcement of significant expenditures in recent years, the Expert Panel (2006) also noted that the federal government has never provided enough funding to provide First Nations communities with water systems of a comparable level to that of off-reserve communities.

As mentioned earlier, there are currently no laws and regulations governing the provision of drinking water in First Nations communities. Instead, the federal government uses policies, administrative guidelines, and funding arrangements to ensure access to safe drinking water (Davids, 2006; Office of the Auditor General, 2005; Graham, 2003; Graham, 2002). The federal guidelines have been described as vague, poorly coordinated, and not implemented consistently (Graham, 2002; O'Connor, 2002; Chiefs of Ontario, 2001). In addition they do not cover all the elements that would be found in a regulatory regime for drinking water in non- First Nations communities throughout Canada (Office of the Auditor General, 2005). Christensen (2006) and the Office of the Auditor General (2005) conclude that residents of First Nations communities will not benefit from a level of drinking water protection comparable to that of people who live off reserves until the federal government puts binding laws in place.

2.4 Water System Capacity

Although the sweeping deficiencies in First Nations drinking water management may seem unrelated, they are all considered components of water system capacity. The use of the term capacity is relatively new in water resource management, even though the concept was recognized as a priority item at the United Nations Water Conference at Mar del Plata in 1977 (Biswas, 1996). At that time, emphasis was placed on the interrelated notions of human resources development and institutional strengthening (Hartvelt and Okun, 1991) which remain integral components of the capacity building process. Capacity building can be described as the practice of gaining technical, managerial, and institutional knowledge and insight in relation to the socio-economic structure, cultural standards and values of the society concerned in order to achieve capacity (Hamdy et al., 1998). Water system capacity can be defined as the ability to plan for, achieve, and maintain compliance with applicable drinking water standards (USEPA, 1998), or more simply as the ability of a system to achieve its objectives (de Loë et al., 2002). Maintaining drinking water standards and therefore possessing capacity is critical in the protection of human health (Soelter and Miller, 1999).

Identified formally for the first time in the 1996 amendments to the United States Safe Drinking Water Act (SDWA) and described thoroughly by USEPA (1998), capacity in the water sector can be considered in terms of three fundamental dimensions: technical, managerial and financial. This view has been adopted and expanded upon in many studies in the field of water resource management (Timmer et al., 2007; Office of the Auditor General, 2005; de Loë and Kreutzwiser, 2005; de Loë and Lukovich, 2004; de Loë et al., 2002; Soelter and Miller, 1999). Furthermore, despite its introduction in the United States, this perspective is broadly consistent with water sector capacity frameworks developed by other organizations in different countries (Pirie et al., 2004).

Technical capacity refers to the physical and operational ability of a water system to meet safe drinking water standards (USEPA, 1998). The three key components of technical capacity are source water adequacy, physical infrastructure adequacy, and technical knowledge and implementation. The quantity and quality of source water are important factors in the ability of a system to provide safe drinking water. Insufficient quantity to meet consumer demands may lead to service interruptions, whereas low quality can result in high treatment costs, greater operational complexity, and pose a hazard to public health (Davies and Mazumder, 2003; Shanaghan and Bielanski, 2003). The presence and condition of physical infrastructure, including wells and/or surface intakes, treatment facilities, pumping stations, storage facilities, and distribution systems, considerably influence drinking water quality. Lastly, technical knowledge and implementation essentially describes the operation and maintenance capabilities of water system operators (Shanaghan and Bielanski, 2003). Operators should be certified to ensure that they can safely run the system.

Managerial capacity can be described as the ability of a water system to conduct its affairs in a manner enabling the system to achieve and maintain compliance with safe drinking water requirements (USEPA, 1998). This dimension emphasises the system's institutional and administrative capabilities by examining the key areas of ownership accountability, staffing and organization, and effective external linkages (USEPA, 1998). Ownership accountability is the cornerstone of a water system capacity, as ultimately the accountability for meeting drinking water standards rests with the system owner (Shanaghan and Bielanski, 2003). Staffing and organization relate to a water system having the sufficient and qualified personnel. Smaller communities typically do not possess the resources to recruit and retain specialized staff, but may still exhibit managerial capacity if they are able to acquire the services of external specialists when required (de Loë et al., 2002; Timmer et al., 2007). Effective external linkages refer to a water system's associations and interactions with customers, technical experts and governing agencies. The presence of well-developed vertical linkages is an important component of capacity (Mcguire et al., 1994; de Loë et al., 2002).

Financial capacity considers the water system's ability to acquire and manage sufficient financial resources to allow the system to achieve and maintain compliance with drinking water requirements (USEPA, 1998). This encompasses three main elements: revenue sufficiency, credit worthiness, and fiscal management and controls (USEPA, 1998). Without adequate revenues, a system will simply be unable to provide water that meets safe drinking water standards. Securing revenues is critical in meeting both the system's day-to-day operations, and future demands (Brown et al., 2005). Credit worthiness relates to the overall financial health, while fiscal management and controls pertain to the management of the system's financial resources (Shanaghan and Bielanski, 2003).

Along with the fundamental technical, managerial, and financial dimensions of capacity, additional factors that influence a water system's ability to provide safe drinking water have been suggested. Many researchers have indicated that political, institutional and social considerations play a significant role in water system capacity

(Timmer et al., 2007; de Loë and Kreutzwiser, 2005; de Loë and Lukovich, 2004; de Loë et al., 2002; Hamdy et al., 1998; Biswas, 1996; Hartvelt and Okun, 1991). Although these dimensions were partially considered under the umbrella of three original components of capacity, they are now treated as separate entities in water system capacity literature.

Political considerations typically involve issues of leadership and partnerships within and outside communities. Effective leadership at the political level provides vital vision and direction in the public sector which allows communities to recognize and respond to changes (de Loë and Lukovich, 2004; de Loë et al., 2002). The first and foremost requirement for efficient water systems is a group of capable managers and operators (Hrudey and Hrudey, 2004; Biswas, 1996). Good leaders will also foster horizontal and vertical linkages with other organizations, communities, and different levels of government. These partnerships will provide the water system with external resources such as technical and financial assistance, thereby increasing capacity (de Loë et al., 2002).

Institutional considerations address the quality of arrangements and delineation of responsibilities. This refers to both the set of rules governing water use and to specific organizational agreements involved in the formulation of water resources laws, regulations, policies, administrative procedures, strategies, programmes, structures, and mandates (Hamdy et al., 1998). In the past, institutional considerations have been treated as a component of the managerial dimension of capacity; however their separation and individual contemplation is beginning to be reflected in the literature. Institutional considerations can be significant determinants of capacity and may even be the most important barrier to improved resource management (de Loë et al., 2002). The main issues are typically overlapping agency responsibilities, fragmented administrative structures, and weak or inappropriate legislation (Office of the Auditor General, 2005; de Loë et al., 2002; Hamdy et al., 1998; Hartvelt and Okun, 1991).

Social considerations refer to factors such as levels of citizen awareness and concern, the quality and quantity of citizen participation is management initiatives, and the extent to which people living in a region see themselves as members of an interacting group (de Loë and Lukovich, 2004; de Loë et al., 2002). Members of the community can play extremely important roles as their participation in decision making can ensure that their interests are taken into account which increases the likelihood that initiatives will be implemented successfully (de Loë and Lukovich, 2004; de Loë et al., 2002). Supportive community members also can enhance capacity by increasing available knowledge, skills, credibility and even financial resources (de Loë and Lukovich, 2004).

The political, institutional, and social aspects of capacity have been treated a number of different ways in the literature. de Loë and Kreutzwiser (2005) considered them as elements of managerial capacity whereas de Loë et al. (2002) described water system capacity as having separate technical, managerial, financial, political, institutional, and social dimensions. A further variation of the facets of capacity was suggested by de Loë and Lukovich (2004) who placed technical, financial, political, institutional, and social factors as components of management capacity. Using different terminology to describe a concept similar to capacity, Flora (2004) considered adequate social and political capital to be components of a successful water management system. Similarly, Dziegielewski and Bik (2004) treated the social and political components of a water system as part of technical assistance and training but noted that these areas contributed to the performance of a water system. More recently, Timmer et al., (2007) renamed the managerial dimension to human resources, and merged political capacity into the social dimension. Despite the various placements of political, institutional, and social dimensions in the capacity framework, their importance in the provision of safe drinking water is rarely disputed.

This discussion has described capacity in terms of its technical, managerial, financial, political, institutional, and social components. It is essential to recognize that capacity is a multi-dimensional phenomenon which cannot be understood satisfactorily from a reductionist perspective (de Loë and Lukovich, 2004). In order to properly assess capacity, consideration of all six elements and the interactions among them is necessary. This is because many aspects of water system operations involve more than one dimension of capacity. For example, infrastructure replacement requires technical knowledge, management planning and oversight, and financial resources (USEPA, 1998). Furthermore, the spending of public funds is a political decision that may require community support along with the creation or modification of an institutional arrangement (de Loë and Lukovich, 2004). A deficiency in one area could disrupt the entire effort and therefore adequate capability in all six dimensions is necessary for a system to possess capacity (USEPA, 1998).

It is also important to recognize that there exists a difference between capacity and drinking water quality. Capacity can be considered as the process of providing drinking water, whereas drinking water quality is the outcome of this process. This distinction is significant as water systems that do not demonstrate capacity may still be capable of providing safe drinking water through favourable circumstances such as extremely high quality source water. Conversely, water systems that fully demonstrate capacity may also provide unsafe water in certain unpredictable situations such as a treatment process malfunction or a chemical spill.

2.5 Challenges for Small Water System Capacity

Demonstrating capacity has repeatedly been identified as a major challenge for drinking water systems serving small communities throughout Canada (e.g., Brown et al., 2005; Coulibaby and Rodriguez, 2003) and the United States (e.g. Braden and Mankin, 2004; NRC, 1997). Compared to larger centres, small communities are often deficient in the financial, technical, human resources, social and political, and institutional capabilities necessary to provide their residents with safe drinking water.

In terms of financial capacity, small communities tend to have economic characteristics that make it difficult to raise funds for a safe water supply service. Financial pressures are typically more pronounced for very small systems and those located in rural areas (Brown et al., 2005; NRC, 1997). Very small systems, defined by the USEPA (2006) as those serving a population between 500 and 3,300 people, lack the economy of scale in the provision of a sustainable water service (Maras, 2004; NRC, 1997). Rural communities tend to have lower per capita incomes, higher unemployment rates, and a larger proportion of aging residents (NRC, 1997). Regardless of the fee structure, obtaining adequate revenue to self-finance infrastructure and operation needs is unfeasible in these communities due to the undersized ratepayer base and low average incomes (Maras, 2004; WCI, 2003; NRC, 1997). In addition, water revenues may be used to address other community needs, contributing to the fact that most small water systems lack reserve funds to help them through difficult periods (Dziegielewski and Bik, 2004). Adequate financial capacity is essential for small water systems and any deficiencies can lead to concerns in other areas (Dziegielewski and Bik, 2004; Soelter and Miller, 1999; NRC, 1997).

Perhaps the most apparent impact a lack of funds may have on a water system is the constraint placed on upgrading aging infrastructure and acquiring new water treatment technologies, reducing technical capacity as a result. In terms of infrastructure, small systems have difficulty replacing older transmission and distribution lines, upgrading treatment procedures, and expanding service to accommodate an increasing population (Brown et al., 2005; Dziegielewski and Bik, 2004; NRC, 1997). The considerable costs of financing the construction, operation, and maintenance of water treatment procedures has led to the recommendation that small systems should invest in new technology only after exhausting all other possible, less costly, options such as finding an alternative water source, linking with another system, or purchasing treated water from another system (NRC, 1997). Due to their location, many small communities have no other options than to turn to their own water treatment operation, but may be able to reduce their costs with the use of package plants: pre-made units that group elements of the treatment process in a compact assembly (NRC, 1997). Without proper infrastructure and treatment technology in place, a water system will not be able to meet regulatory requirements and ultimately to provide clean water (Brown et al., 2005).

Insufficient finances may also negatively impact a water system's human resources capacity. Competent personnel are vital to the safe operation of a water system, however many small communities can not afford qualified operators and lack revenues to hire experienced managers (Dziegielewski and Bik, 2004; Maras, 2004; NRC, 1997). As a result small water systems often have part time officials and few, if any, full-time staff members to undertake and oversee operational activities (Braden and Mankin, 2004; Dziegielewski and Bik, 2004). Along with financial difficulties, human resources capacity of small water systems is also affected by challenges related to social trends and their geographic locations. Many small water systems are situated in aging communities who have not retained younger citizens, leaving a declining available human resources pool to operate the system (Braden and Mankin, 2004). As a result, many small system operators come to their positions through circuitous circumstances with relatively little formal training and rely on the programs provided by higher levels of government to increase their qualifications (NRC, 1997). However, the technical assistance for and training of small water system operators is often unavailable or inadequate (Dziegielewski and Bik, 2004; NRC, 1997). This is due to the remote location of some small systems, the cost of reaching and attending training courses, a lack of consistent training standards and certification requirements, and programs geared towards larger systems that fail to give small system operators the knowledge and practical training that they require (NRC, 1997).

Deficiencies in the social and political capacity of small water systems are generally related to the broader conditions within their communities. Community commitment is critical to the effective operation of small water systems and is often a reflection of the resources and abilities of community residents (Dziegielewski and Bik, 2004; Flora, 2004). Unfortunately many small communities have a high percentage of low-income residents or senior citizens which reduce their social and political capabilities related to water system management (Dziegielewski and Bik, 2004). Capacity decreases even further when horizontal and vertical linkages, or the internal and external partnerships of a water system, are weak within small communities. Dziegielewski and Bik (2004) noted that failures in communication among and between members of the public, water system operators, and elected officials are central to many small system problems including financial pressures and delayed responses to system needs.

Finally, the institutional capacity of small water systems is also mediocre in some areas. Many systems are incapable of developing and carrying out the planning necessary for long-term improvements to their water service (NRC, 1997). Small communities may lack the resources required to acquire information about future population, water users, water demand, current and future yield of water sources, source water quality, treatment methods, environmental impacts associated with the water system, financing, and capital and operational costs, making them reliant on outside assistance (NRC, 1997). Although it is true that higher levels of government have a strong influence on the institutional environment of water management in most communities, plans guiding actions for the regular provision of drinking water should also be developed at the local level.

To make matters more difficult for small systems, at least in parts of the United States, the challenges they face are compounded by an ever increasing number of drinking water regulations that must be met or fines will be imposed (NRC, 1997). The shortcomings in the financial, technical, human resources, social/political, and institutional capacity of small water systems illustrate the position taken by the Expert Panel (2006) that the small size of a drinking water system alone is a known risk in the provision of safe drinking water.

2.6 Challenges for First Nations Water System Capacity

The majority of the 761 First Nations water systems across Canada are located in small communities ranging in size from 50 to 10,000 persons (INAC, 2003; Holden, 1999). Therefore, they face the challenges with respect to demonstrating capacity common to all small systems. In addition to the barriers discussed in Section 2.5, First Nations communities also encounter further, significant difficulties in the provision of drinking water related to their location, costs and financing, and population growth.

Many First Nations communities are located in remote areas and/or on difficult terrain like the Canadian Shield (Davids, 2006; Expert Panel, 2006: Smith et al., 2006; Office of the Auditor General, 2005). Approximately one in seven is a “special access community” and can be reached only by water or by a combination of air in summer and snow roads in winter (Expert Panel, 2006; Office of the Auditor General, 2005). Some communities also have limited access to electricity or other forms of energy, and have source water that is scarce, difficult to treat, or both (Expert Panel, 2006; Office of the Auditor General, 2005). The isolated location and difficult conditions combine to make the provision of drinking technically difficult and expensive in many First Nations communities (Davids, 2006; Office of the Auditor General 2005). Furthermore, obtaining assistance and supplies, even during crises, is difficult, slow, and costly (Expert Panel, 2006).

Regardless of the location, providing drinking water is capital intensive and expensive (Davids, 2006; Office of the Auditor General, 2005). As discussed in Section 2.5, there is limited potential for achieving the economy of scale in small communities which renders capital and operating costs high for each connection. The large distances separating First Nations communities from other settlements prevents the possibility of consolidating capital, human, and other resources to save money and reduce risks (Expert Panel, 2006). Although water systems are largely financed by the federal government, the poor economic conditions of First Nations communities limits their access to funding for water projects and to regular revenues to cover a portion of operation and maintenance costs (Office of the Auditor General). Consequently, many First Nations communities are often faced with a built-in shortfall in funding available for water system needs (Office of the Auditor General, 2005). In other words, the operation and maintenance of community water systems are completely dependent upon federal government money (Smith et al., 2006)

The rate of population growth in many First Nations communities is considerably higher than in the rest of Canada. This is due to birth rates being twice the Canadian average and the social trend of First Nations returning to their ancestral homes (Parsons, 2003). On-reserve population is expected to increase by 230,000 people between 2004 and 2021 (Office of the Auditor General, 2005). INAC's policy for sizing systems does not take into account the amount of population growth in First Nations communities which results in some systems being undersized as soon as they are commissioned (Expert Panel, 2006). However, even if changes to policy are made, it is difficult to accurately estimate growth and economic development in each community to design water systems that can meet drinking water needs for 10-20 years (Office of the Auditor General, 2005). Population growth increases the demand placed on water systems. This can result in water shortages, operational safety concerns, or increased expenditures to upgrade the system before the end of its planned service life (Expert Panel, 2006; Parsons, 2003).

2.7 Summary

The literature on First Nations drinking water reveals a longstanding public health issue that has improved very little despite considerable initiatives to address the situation.

There are several common deficiencies in the safety of First Nations drinking water systems including funding shortfalls, unqualified personnel, an absence of laws and regulations, management complexity, and inadequate infrastructure. The concept of capacity permits an examination of the ability of water systems to produce safe drinking water based on interrelated dimensions. Achieving water system capacity has been demonstrated to be very challenging for small water systems, and more so for First Nations water systems. From this point onward, the capacity of Montreal Lake's drinking water system will be assessed based on its financial, human resources, institutional, social/political, and technical dimensions.

3.0 Montreal Lake Drinking Water

3.1 Community Profile

Montreal Lake's main town site is situated on the southwest end of Montreal Lake (Figure 3.1) on Indian Reserve #106, the main reserve set aside for members of the Montreal Lake Cree Nation. Climate in the region is influenced strongly by the mid-

Figure 3.1 Aerial View of Montreal Lake
Source: Prince Albert Grand Council. 2005. *Prince Albert Grand Council 2004 Annual Report*. Prince Albert, Saskatchewan

continental position resulting in temperatures and total annual precipitation ranging from -40ºC to 32ºC and 400 to 500 mm respectively (NFC, 1996). Montreal Lake is located within the Prince Albert Model Forest area and just outside the eastern boundary of Prince Albert National Park (Figure 3.2). The community can be accessed year-round by a gravel road that branches off a major provincial highway and is approximately 235km north of Saskatoon.

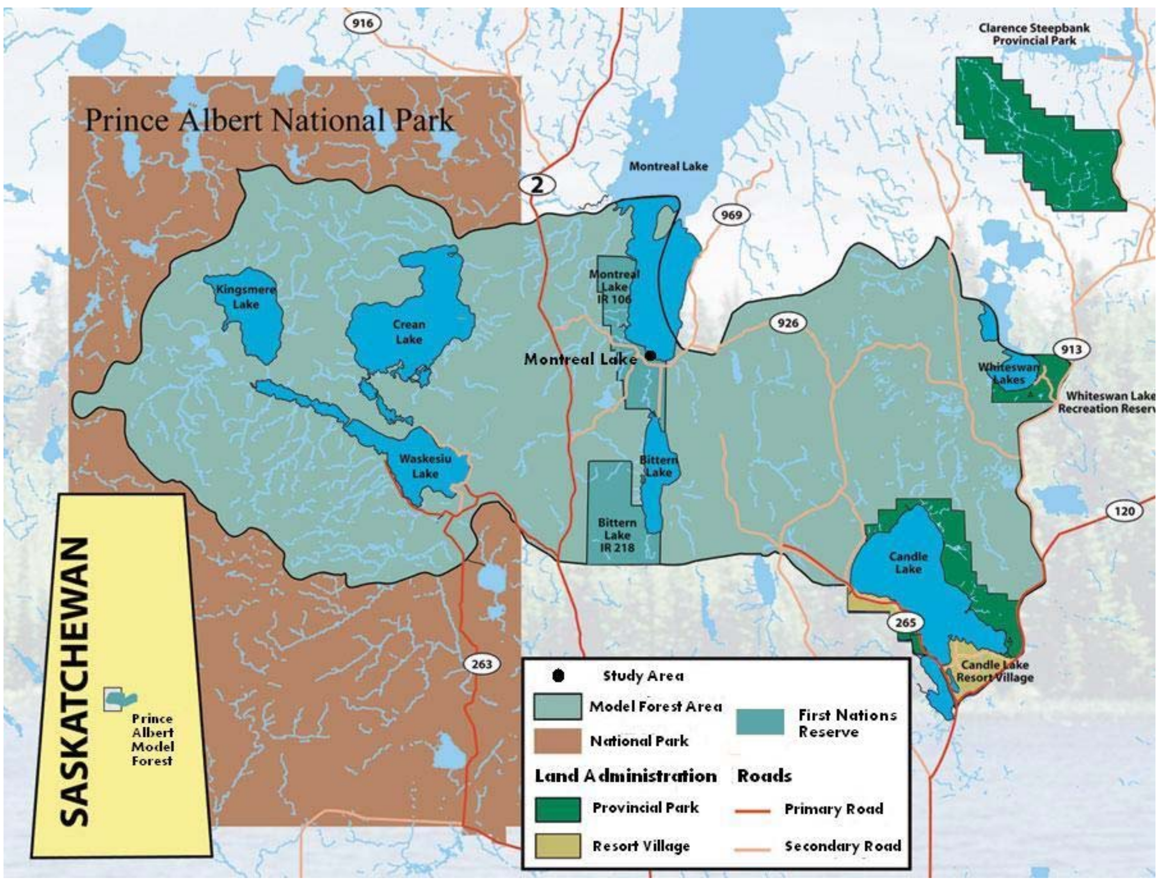

Figure 3.2 Montreal Lake Region
Modified from: Prince Albert Model Forest. 2006. *The Prince Albert Model Forest Area and* Vicinity [Online]. http://mfiqlx.sasktelwebhosting.com/map.html. Accessed 01-June-2007.

Members of the Montreal Lake Cree Nation reside in various communities throughout the region and are part of the Woodland Cree and the Prince Albert Grand Council. According to INAC (2007b), the community of Montreal Lake has a registered on-reserve population of 1877 people. However, there exists some haziness in the population data as Statistics Canada (2007a) established a population of 880 residents for Montreal Lake in the 2006 Census. The data provided by INAC (2007b) was used in this study for the reason that case study documents detailing the population served by the water system corresponded closely to their figures. The community's population is growing rapidly and can be described as young, with a high percentage not yet of working age, and almost entirely Aboriginal. Montreal Lake is considered to be cohesive barring a few isolated events with high priorities centered on providing opportunities for the youth population, community-wide solidarity, and the availability of basic services (Brklacich and Woodrow, 2007; Parkins et al., 2001). Employment opportunities are limited and have been especially impacted in recent years by declining forestry operations and the closure of the commercial fishery on Montreal Lake. As a result, many residents are forced to search for work elsewhere in the province and beyond. The most recent data reveal that the community's unemployment rate rose to 31.3% in 2001 from 30.3% in 1996 (INAC, 2007b). However some Band-based initiatives, notably in the manufacturing of ready-to-move homes, have been very successful and are continuing to grow and expand their labour force. Montreal Lake is governed by their elected chief, two vice-chiefs, and twelve councillors, who continue to be active and vocal in an effort to improve their community's socio-economic situation as they have done in the past (Brklacich and Woodrow, 2007; Goode et al., 1996).

3.2 Montreal Lake Drinking Water System

As a primary objective of this study is to determine the ability of Montreal Lake to provide safe drinking water to its residents, the following sections will describe the specifics of the water system.

3.2.1 Drinking Water Source

The community's raw water source consists of surface water drawn directly from Montreal Lake, one of the largest freshwater lakes in central Saskatchewan. It is an elongated body of water with its long axis running north-south and including islands, its net area is 454 km^2 (Natural Resources Canada, 2004). Montreal Lake is part of the Churchill River Watershed and drains northward through Montreal River into the Churchill River Basin. Since it is located near a watershed boundary, local precipitation supplies over 95 percent of the water in Montreal Lake as it does for the entire Churchill River system (SWA, 2006). In general, lakes offer surface water with the most consistent quality but are subject to considerable change in the spring and autumn (PWGSC, 2000a). During these periods known as lake turnover, where a lake changes from cool to warm in the spring and then shifts back from warm to cool in autumn, a stage is reached at which temperature becomes almost uniform throughout the entire lake and stratification disappears (Pielou, 1998). Without the density differences within a lake, deeper layers of water are free to circulate and move towards the surface, bringing sediments which temporarily reduce water quality (PWGSC, 2000a; Pielou, 1998). Lake turnover is typically more pronounced during the spring in Montreal Lake where higher turbidity and colour are noted in water samples.

Presently, there is no source water protection plan for the Montreal Lake watershed. Under the First Nations Water Management Strategy, Environment Canada has been developing a guide which should be complete in 2008 designed to aid operating authorities of water systems in First Nations communities create of their own source water protection plan (INAC, 2006a). Even without protection measures in place, Montreal Lake offers high quality source water. The lake is surrounded by natural forest and is completely undeveloped. In terms of potential contaminants affecting the quality of the drinking water, there are only minor concerns. There is some forestry activity in the region and some recreational use of the lake, but overall the source water can be considered ideal. However small changes in the watershed within the community, in particular the conversion of a forested area to an open field, have led to a noticeable increase in the amount of sediment and waste picked up by the intake pipe. Even without the immediate threat of contamination, source water protection has repeatedly been identified as the first critical element of a multi-barrier approach to drinking water safety (INAC, 2006a; Hrudey and Hrudey, 2004; McQuigge, 2002; O'Connor, 2002).

Although there is little direct stress from human activity, Montreal Lake is subject to acid deposition like the rest of the Churchill River Basin (SWA, 2007). Changes in pH levels can alter the chemistry of source waters and subsequently impact the biological composition and functional ability of the aquatic ecosystem (SWA 2007, CCME, 2004). The amount of acid deposition in the Churchill River Basin and its potential impacts on aquatic ecosystems led SWA (2007) to the conclusion that the watershed is currently in an impaired state of health. However, in terms of drinking water safety, Montreal Lake annual raw water quality data consistently reveal a pH level between the aesthetic objective range of 6.5-8.5 specified in the GCDWQ.

Situated on the shore of a large freshwater lake, it seems logical that surface water would be selected as the community's raw water source. However, prior to the construction of the Montreal Lake Water Treatment Plant in 1993, groundwater was the source of the community's drinking water. There are advantages of having a groundwater source instead of surface water, as it maintains a fairly consistent temperature year-round, usually contains fewer contaminants, and suspended matter is filtered out as groundwater passes through various layers of earth (PWGSC, 2000a). For these reasons, groundwater usually requires little or no treatment to meet water quality standards which also makes it a more cost effective source than surface water (PWGSC, 2000a). On the other hand, groundwater is also in contact with soil and rock which results in mineral and organic matter being dissolved into the water, the most common of which is the dissolution of carbonate rocks (Sullivan et al., 2005). The resulting "hard" or alkaline water is not hazardous to human health but does have an unpleasant taste, prevents the lathering of soap and leads to scale build-up in kettles, other cooking utensils, and water heaters (PWGSC, 2000a). Community leaders in Montreal Lake recognized the disadvantages of their groundwater supply, in particular the scale build-up in water heaters, and lobbied to change the drinking water source to surface water prior to the construction of the water treatment plant. It may also have been determined that groundwater was not of sufficient quantity to support the community's rapidly growing population. The neighbouring northern hamlet of Timber Bay, located 18km away on the eastern shore of Montreal Lake, still uses groundwater and many of its 139 residents consider their water to be inferior due to its high alkalinity.

3.2.2 Treatment

The Montreal Lake Water Treatment Plant is located in the community core and was completely developed from the ground up in 1993. All systems, including the water mains, lake intake, raw water pumping station, and underground infrastructure, were upgraded in 1997. The latest plant upgrade took place in 2004 where the capacity of the reservoir and the capacity of the treatment units were both doubled. The treatment plant is fairly modern and is described as completely up to date considering its recent construction and amount of upgrades.

The plant consists of two US Filter Microfloc® Trimite™ TM-100A package surface water treatment units. The first stage of the treatment process consists of upflow through an adsorption clarifier which is designed to generally remove 75-95% of the raw water turbidity before sending the flow for multimedia (rapid sand) filtration. Prior to entering the treatment unit, the raw water is dosed with a coagulant called ClearPac Plus and a non ionic polymer. Coagulation refers to the removal of fine particles (colloids that remain in suspension) by destabilizing the charge repulsion that keeps them from coalescing into larger aggregates, whereas the non ionic polymer assists in the process of flocculation, or the agglomeration of these particles once the charge has been destabilized (Hrudey and Hrudey, 2004; Faust and Aly, 1998). The filtered water is then disinfected with a chlorine solution prior to being placed in one of two underground storage reservoirs which also serve as the foundation of the water treatment plant. Each treatment unit can provide 100 US gpm or 379 lpm in optimal conditions for a plant total of 200 US gpm or 758 lpm, which currently exceeds the demand within the community and is estimated to be sufficient for several years to come. The total storage capacity of the reservoirs is approximately 403,000 litres which also meets current water demands. However, even though the storage capacity was doubled in 2004, using the two (2) times average day design guideline, the reservoir will require additional storage capacity in the near future.

The processes of coagulation, flocculation and filtration contribute to lowering the number of microorganisms that appear in treated water because they are explicitly designed to remove suspended material (Hrudey and Hrudey, 2004). The additional process of disinfection is justified by the need to achieve a high degree of assurance that pathogenic microbes do not reach consumers and in a condition capable of causing waterborne diseases (Hrudey and Hrudey, 2004; Faust and Aly, 1998). Montreal Lake uses chlorination, which is the most widely used and generally the most cost-effective means of disinfection (Hrudey and Hrudey, 2004; Faust and Aly, 1998). In addition, an important aspect of chlorine as a disinfectant is its ability to persist in residual concentrations as a safeguard against recontamination in the distribution system (Faust and Aly, 1998).

3.2.3 Monitoring

The drinking water monitoring responsibilities within Montreal Lake are split between the community's Environmental Health Officer (EHO), who is based out of the Prince Albert Grand Council (PAGC), and its water treatment plant operators. Health Canada funds both groups and provides the equipment necessary for sampling and testing, but all other activities normally carried out the department's employees have been fully transferred, which is also the case in other First Nations communities (Health Canada, 2007; Office of the Auditor General, 2005). Monitoring is a crucial component in the provision of drinking water as it can lead to early detection of potential issues which may decrease water quality and provides an ongoing evaluation of a water system's effectiveness and reliability (Smith et al., 2006).

In most First Nations communities, there is either a Water Quality Technician (WQT) or a Community-based Drinking Water Quality Monitor (CBWM) present to provide a final check on the overall safety of the drinking water (Health Canada, 2007a; INAC, 2004). Specifically, the WQT or CBWM is responsible for monitoring the bacteriological water quality by collecting samples and testing for the presence or absence of coliforms and *E. coli*. Most coliforms and strains of *E. coli* do not cause disease and normally play an essential role in human digestion (Hrudey and Hrudey, 2004). They are used instead as indicators in drinking water monitoring, as their presence is a sign that disease causing organisms may also be present (Hrudey and Hrudey, 2004; Saskatchewan Environment, 2003). Montreal Lake does not have a WQT or CBWM and instead the associated duties are performed by the water treatment plant operators who are normally responsible for monitoring total and free chlorine residuals and ensuring the proper operation of water treatment plant processes such as the reduction of turbidity. Knowledge of chlorine residual levels in treated water is vital to a system's performance as it provides disinfection capacity for microbial contamination in the distribution system and a measure of whether adequate conditions for disinfection are being maintained (Hrudey and Hrudey, 2004). Daily turbidity readings are also necessary to gauge a plant's performance as substantial turbidity may allow individual pathogens to be shielded from disinfection (Hrudey and Hrudey, 2004). The Montreal Lake water treatment operators are expected to take and analyze bacteriological and chlorine residual samples a total of five times a week from different locations along the piped distribution system, and perform daily turbidity readings at the plant. As a number of homes within the community use a truck haul system for their drinking water, water trucks are to be sampled every two weeks while individual cisterns are supposed to be sampled and tested every three months.

As part of PAGC Health and Social Development, the EHO for Montreal Lake oversees health concerns such as air quality and communicable diseases in addition to water monitoring for several bands throughout north-central Saskatchewan. In terms of water monitoring, the main responsibility of the EHO is to review and interpret drinking water quality tests and disseminate the results back to the community and to other stakeholders such as INAC (Health Canada, 2007a; INAC, 2004). Results from the weekly samples conducted by the water treatment plant operators are sent to the EHO for quality assurance and quality control. Once a year, the EHO will collect and submit both raw and treated water samples to an accredited laboratory where they will be tested for the full range of chemical, physical, and radiological contaminants. Montreal Lake's EHO also assists the water treatment plant operators in the monitoring of trihalomethanes. Samples for these disinfection by-products are taken 4 times a year as they have to be worked out over an annual average, and are sent to an accredited laboratory for analysis.

3.2.4 Distribution

Montreal Lake uses a combination of a fully piped distribution system and a community haul trucked system to deliver drinking water to its residents. There are currently 131 homes connected to the water treatment plant while 86 have water trucked to their cisterns (on-site storage tanks). During the summer of 2007, an additional 36 homes will be hooked up to the piped distribution system with the possibility of more the following year. However it is very unlikely that all homes will eventually be hooked up to the system due to the large distances between the community core and outlying residences.

Piped systems are usually the most efficient and safest means of distributing water, but, as in the case of Montreal Lake, may not be the most cost-effective option (PWGSC, 2000a). All the water main piping in the community is made of polyethylene. Polyethylene is a lightweight plastic that is flexible and easy to handle in the field which makes installation and repairs simpler and easier than ductile iron (PWGSC, 2000a). The piping is also looped throughout the community, in the sense that there is more than one way to deliver water to a residence. This is an important aspect of a distribution system, as it reduces water service interruptions in the event of a water main break. In particular, the distribution system should be equipped with shut-off valves located in a way that allows the broken section on the line to be isolated, thereby reducing the number of residences affected by the break by permitting water to reach them from the other direction (PWGSC, 2000a). In Montreal Lake there are periodic water main breaks within the community. Full service can be restored within 4-5 hours, but the entire system may be shut down in the process to address the situation. Unfortunately, there are widespread service interruptions even when the entire system is not shut down due to a lack of shut-off valves along the distribution lines. The water treatment plant operators would like to install an additional 15 shut-off valves in the future to improve water service to residents.

As mentioned above, truck haul delivery is a cost-effective option for assuring a relatively safe water supply in communities like Montreal Lake where some residences are too spread out for a piped system to be viable (PWGSC, 2000a). Montreal Lake has two water trucks that split delivery. They operate every other day or as needed and are capable of meeting the demand for water in outlying homes. The water provided to the trucks comes directly from one of the treatment plant's two reservoirs, and therefore is of the same quality as the water found in the piped distribution system. However, there is opportunity for contamination to occur at the loading, transport and unloading steps in the trucked delivery system, in particular, through improper handling or failure to periodically clean trucks, hoses, and tanks (Expert Panel, 2006; PWGSC, 2000a). INAC is currently reviewing the technical requirements for trucked water systems including responsibilities and the training and certification of truck operators (INAC, 2006a).

The most significant health issue present in Montreal Lake's trucked delivery system resides in the storage of water in cisterns. The individual cisterns are prone to positive bacteria tests and there are often boil water advisories issued for users until the cisterns are repaired or cleaned. The possible reasons for bacterial contamination may be cracking of tanks, misaligned manhole riser sections allowing infiltration, or depleted chlorine residual from long durations in periods of low use. In Montreal Lake, the movement in the ground is particularly damaging and forced the replacement of twenty cisterns during the fall of 2006.

Six homes within Montreal Lake obtain their drinking water from individual wells. When properly constructed and maintained, private wells are usually a good source of water for individual residences (PWGSC, 2000a). However, poor water quality has been reported in these wells within Montreal Lake. In spite of this, as these homes are responsible for their drinking water provision and are not part of the community's water systems, they were not considered any further in this study.

3.2.5 Montreal Lake Wastewater System

As in the case of most First Nations communities, Montreal Lake uses a facultative sewage lagoon for wastewater treatment (PWGSC, 2000b). Fully piped gravity flow and community haul systems are used for wastewater collection. Most of the homes are connected to an underground network of pipes which carries wastewater directly to the disposal site. However, due to the large distance separating some of the houses, a truck haul system is also in place within the community.

Facultative lagoons are the most common wastewater treatment process in Canada as they offer communities low capital and low operation and maintenance costs, the ability to handle hydraulic and organic shock loads, and minimum operator attention (PWGSC, 2000b). Montreal Lake's two cell facultative lagoon consists of a primary treatment cell of 3.1 ha and a storage cell with a capacity of 40,000m^3. The treatment cell relies on natural processes such as bacteria and algae to reduce organic matter to acceptable levels, which may be significantly reduced during cold weather (PWGSC, 2000b). The storage cell has sufficient volume for 180 day storage which meets provincial guidelines and is considered to be capable of providing secondary treatment during summer months (Saskatchewan Environment, 2002). The facility, including two pumping stations, was constructed in 1993 and despite land area limitations due to the conditions of soils, the muskeg, the lake, and the community, the lagoon is situated approximately 300m from the nearest residences which meets the Saskatchewan Environment (2002) *Guidelines for Sewage Works Design*. The lagoon is also surrounded by old growth forest which acts as good buffer from the community.

The sewage pumping stations are both typical wet pit/submersible pump configurations with a pumphouse building, meaning the pumps are immersed in the liquid handled. (PWGSC, 2000b). The water services for each station do not have any form of backflow prevention, which could allow sewage to backup into building basements in the event of a power or pump failure. However, emergency plans are in place in case of sewage overflow.

The lagoon is designed to be discharged twice annually; once in the spring three to four weeks after ice break-up and then again in the fall prior to freeze up. In Montreal Lake, the effluent is discharged into a natural muskeg area where it must travel for approximately 250m prior to reaching the creek that eventually runs into the lake. According to INAC engineers and approved by Environment Canada, the passage through the muskeg is similar to tertiary (third level) treatment. Effluent is eventually released on the same shore of as the water intake pipe, approximately 1100m away. As

Montreal Lake is large, this is not considered to be directly upstream, however, certain conditions may dictate otherwise. Within the community, significant public concern exists and is voiced in regards to the proximity of the lagoon to the lake. In particular, many residents believe that the effluent is discharged without being sufficiently treated. Effluent tests are conducted every four years and although the pH parameter exceeded the targeted range of 6.5 to 8.5 at the most recent sampling, it is not considered to be a risk to public health. Shortly after the storage cell was discharged in the spring of 2007 and at the urging of community residents and the Band Council, samples were taken from the lake at the effluent's point of entry to determine the impact on water quality.

3.2.6 Funding

The economic realities for many First Nations communities create a reliance on outside sources of funding from the federal government for the operation, maintenance, and construction of their water systems (Expert Panel, 2006; Wilson, 2004). This situation rightly describes Montreal Lake as all funds earmarked for their water system are supplied by either INAC or Health Canada. INAC covers the entire costs of capital construction and upgrading, operation, and maintenance of the water and wastewater facilities within the community. According to INAC's operation and maintenance guidelines, First Nations Chief and Council are responsible for assuming partial financial responsibility for a portion of the operation and maintenance costs of water systems through user fees and/or other revenue sources (Office of the Auditor General, 2005; INAC, 2004; INAC, 1998). However, similar to many First Nations communities this does not occur in Montreal Lake as user fees are not collected nor is the water metered in the community (Office of the Auditor General, 2005). Montreal Lake receives $156,700 from INAC each fiscal year to maintain the water and wastewater system from the lake intake all the way through the system right to the lagoon. Within the annual funding, each individual item is allocated a specific amount for annual operation and maintenance costs. As per funding agreements, INAC will monitor and assess the financial and project delivery performance under the Capital Facilities and Maintenance Program, and will conduct a thorough facility inspection under the Asset Condition Reporting System every three years (INAC, 2004). In addition to financing the community's water and wastewater facilities, INAC also funds the salaries of Montreal Lake's water treatment plant operators. Furthermore, INAC funds the PAGC to hire utilities trainers, who in turn are responsible for providing community operators with technical assistance.

Under the Drinking Water Safety Program, Health Canada funds the monitoring of drinking water quality in First Nations community drinking water systems with five or more connections and cisterns (INAC, 2004). In Montreal Lake, the responsibility for monitoring drinking water has been fully transferred to First Nations authorities. Health Canada provides the funding for the chemicals and equipment used for water quality monitoring and finances the PAGC to hire environmental health officers for quality assurance and quality control of the water samples.

3.2.7 Operators

The lack of water treatment plant operators in First Nations communities meeting certification requirements to properly operate their facilities has been repeatedly identified as a major issue in the provision of safe drinking water (Smith et al., 2006; Office of the Auditor General, 2005; INAC, 2003; Holden, 1999; Moore, 1999). Montreal Lake's water treatment plant is operated by one full-time operator and a part-time backup operator who both reside within the community. In order to obtain certification, operators must pass the appropriate exams for the level or their water treatment plant, distribution system, wastewater treatment, and wastewater collection, and satisfy the criteria for on the job experience. Montreal Lake is a Level II water treatment plant which requires an operator to have had three years of experience and passed both the Level I and Level II exams. Currently the primary operator is not certified to the level of Montreal Lake's water treatment plant.

3.2.8 Future Development

As is the case for many First Nations communities across Canada, the population of Montreal Lake has been rapidly growing for a number of years. The Office of the Auditor General (2005) identified expanding populations in First Nations communities as a key challenge in planning water systems that can meet drinking water needs for 10 to 20 years. To accommodate the growing population and demand for housing within Montreal Lake, a new subdivision will be constructed beginning in the 2007-2008 fiscal year. The plans for the Bittern Lake Subdivision were designed in 2000-2001, but INAC has delayed development until the Montreal Lake Cree Nation completes the current subdivision in the 2006-2007 fiscal year. The new subdivision will be located some distance away from the community core, as there is not a sufficient amount of developable land in the original core area due to the presence of muskegs. Construction will take place in stages with an estimated cost of $6.5 million and timeframe of two years for completion. The design calls for 238 lots complete with water and sewer mains, service connections to houses, fire hydrants, a second reservoir and pumphouse, a new lift station for sewage, and a new lagoon. Considering the treatment plant's current capabilities and the forthcoming upgrades to the water system, it is expected that Montreal Lake's drinking water needs, in terms of quantity at the very least, will be satisfied into the near future.

4.0 Methodology

The results of this research are intended to be generalizable to other First Nations communities, thereby becoming an instrumental case study (Stake, 2005). Case study research involves the collection of data from multiple sources and subsequent triangulation, which is the process of using diverse data to substantiate an interpretation or clarify meaning (Stake, 2005; Yin, 2003; Stake, 1995). Data collected in this study came from individual interviews, a community workshop, document analysis, and water quality samples. Montreal Lake, SK was selected as the case study community for several reasons. The location, size, and stability of Montreal Lake provided an opportunity to apply the water system capacity framework and assess a situation that is not in crisis. In addition, as part of a larger joint project with Carleton University and Simon Fraser University titled *A Comparative Assessment of the Capacity of Canadian Rural Communities to Adapt to Uncertain Futures*, I had already anticipated conducting research within the community. This emerging relationship between community residents and members of the Department of Geography at the University of Saskatchewan provided a platform to proceed with the study. Residents were agreeable and this association greatly facilitated fieldwork, permitting at times concurrent data collection for both projects and increasing the level of familiarity with the community. Furthermore, by providing a continued presence at Montreal Lake over 14 months, I hoped to increase trust with participation from residents. In total, approximately 20-25 visits to the community were made during the research phase.

4.1 Data Collection

4.1.1 Interviews

Interviews were conducted with individuals directly responsible for providing the residents of Montreal Lake with safe drinking water. Interviews have been extensively utilized in previous research assessing capacity in water resource management (Timmer et al., 2007; Brown et al., 2005; Ivey et al., 2004; Pirie et al., 2004; Durley et al., 2003; de Loë et al., 2002). The provision of drinking water in a First Nations community involves different levels of government which is often cited as a major complexity in running water systems safely and efficiently (Expert Panel, 2006; Office of the Auditor General, 2005). Participants were selected based on their role in water management and represent the three levels of government involved in the provision of drinking water in Montreal Lake: the Band Council, Tribal Council, and Federal Government. The specialized focus of this project limited the interview participants to the full-time Montreal Lake Water Treatment Plant Operator, a Montreal Lake Band Councillor, a Prince Albert Grand Council (PAGC) Environmental Health Officer, a PAGC Utilities Trainer, and an Indian and Northern Affairs Canada (INAC) Project Technologist. These five individuals constitute the list of key personnel involved in the provision of drinking water within the community. I also requested an interview with a senior INAC Engineer at the department's Regional Office in Regina to acquire of overview of First Nations drinking water management in the province of Saskatchewan. However, the request was refused by the potential participant citing an aversion for becoming a spokesperson for INAC.

By targeting the specific people deemed to be knowledgeable about the community's water system, detailed and thoughtful information was acquired in a short period of time (Markey et al., 2001). Information pertaining to the management of drinking water is fairly specific in areas such as source water protection, treatment procedures, relationships between government and First Nations agencies, operation and maintenance, guidelines and regulations, infrastructure, and financial support. As a result, only those directly involved in the provision of drinking water to the residents of Montreal Lake were considered able to contribute this kind of information, and therefore suitable interviews.

Interview responses were the primary data source for the assessment of financial, social/political, and human resources capacity, and provided insight into institutional and technical capacity. Responses were also used to verify information from the workshop and from relevant documents. Interview questions examining financial, human resources, institutional, social/political, and technical capacity were adapted from Timmer (2003). Additional questions were designed to provide details specific to the Montreal Lake and First Nations contexts of drinking water management (see Appendix 1 for the entire list of guiding interview questions). Semi-structured interviews, with a combination of closed and open-ended questions, were used to provide respondents with an opening to articulate what is important to them and expand upon the depth of the discussion at any given time. Furthermore, this approach also provided me with the opportunity to spontaneously introduce further questions along certain lines of inquiry (Judd et al., 1991). If necessary, the set of interview questions was modified slightly for each participant, as each interviewee was expected to have unique knowledge of certain aspects of drinking water management within the community (Stake, 1995). For example, the community-based water system personnel (the primary water treatment plant operator and Band Councillor) were asked to describe their relationship with the PAGC and INAC, and whether, as residents of Montreal Lake, they had any concerns relating to water quality.

All interviews were conducted in person during three field visits from September 2006 to February 2007, and ranged in length between 30 and 50 minutes. An additional written response to interview questions was also submitted by another Montreal Lake Band Councillor, however this individual was not available to be interviewed in person. Interviewees were informed of the conditions of their voluntary participation, such as audio-recording, and informed consent was obtained. Verbatim transcripts were used for analysis, but only synthesized results are reported in this thesis. Attempts were made to protect the anonymity of the participants by removing identifying markers and aggregating responses. Follow-up meetings were conducted with several participants to fill in any gaps in research data shortly after the completion of the interviews. The gaps in research data refer to specific characteristics of the water system that were not captured in the original series of interview questions. For example, information relating to the frequency of bacteriological monitoring within the piped distribution system and cistern sampling within Montreal Lake was obtained during follow-up meetings. Once the preliminary analysis of capacity was reached, each participant was hand-delivered a copy of the report including background information and assessment criteria for validation. Approval to use the data was obtained from all participants.

4.1.2 Workshop

As part of the project titled *A Comparative Assessment of the Capacity of Canadian Rural Communities to Adapt to Uncertain Futures*, a community workshop was conducted in Montreal Lake. The workshop focused on determining the ability of the communities to adapt to both socio-economic and environmental pressures in the future. Discussion followed a four step framework and was loosely guided by a standardized set of questions (see Appendix 2, parts A through D). Immediately following the completion of the joint project's agenda, participants were asked to discuss Montreal Lake's drinking water and any concerns they had in regards to the current and future state of the community's water system (see Appendix 2, part E). It was assumed that water quality was a general issue of concern for First Nations communities (CBC News, 2006), and that it would also be an area of interest for the residents of Montreal Lake. Their opinions, although not necessarily statistically representative of the community, did provide a sense of the public perception towards drinking water safety within Montreal Lake. Furthermore, the workshop setting provided a safe environment for open discussion and the opportunity for residents to discuss the specific strengths and weaknesses of their community (Markey et al., 2001) which was evident in the views that were expressed.

The workshop lasted approximately 4 hours and was attended by sixteen participants including representatives from the Elders Council, Band Council, Resource and Environment Office, Montreal Lake School, William Charles Health Centre, Montreal Lake Child and Family Agency, Youth Council, and members of the general public. Participants were selected with the assistance of the study's key informants in order to ensure the most fair and equitable representation of the community's groups as possible. This approach was similar to that of Parkins et al. (2001) who examined sustainability within the community of Montreal Lake. During the workshop, the participants were asked to answer and discuss each question; having the opportunity to do so uninterrupted. Before the next question was introduced, participants were invited to comment on the previous responses. The size of the workshop was ideal as it was small enough for everyone to have the opportunity to share insights and yet large enough to include a diversity of perceptions (Krueger, 1994). The workshop dialogue was independently chronicled by two researchers from the joint project (including myself) and a rapporteur to ensure that the forum's key points were captured. Results from the workshop were presented in a synthesized format. Prior to the Brklacich and Woodrow (2007) final report being made public, a preliminary draft was sent to each participant for verification. The final report includes information obtained from the additional questions pertaining specifically to drinking water in Montreal Lake, and assisted the assessment of social/political capacity.

All participants were advised of the conditions of their voluntary participation and informed consent was obtained prior to the workshop's commencement. At the workshop's conclusion, an honorarium was offered to all participants for their contributions to the project.

4.1.3 Water Quality Data

A range of water quality data was obtained to provide a technical measure of current drinking water safety in Montreal Lake. Data that were examined include a series of annual results, a series of weekly results, and a surface water sample taken after the spring discharge of the wastewater lagoon. The three main purposes of water quality data analysis were to compare results to the standards and objectives found in Health Canada's *Guidelines for Canadian Drinking Water Quality* (GCDWQ), to determine if there had been any changes over time in the community's supply, and to identify what kinds of tests were being conducted to monitor drinking water safety. The GCDWQ are regularly updated and information published online supersedes the Health Canada (1996) published booklet (Health Canada, 2007b).

On an annual basis, the community's Environmental Health Officer (EHO) takes raw and treated water samples and sends them to a laboratory accredited by the Canadian Association for Environmental Analytical Laboratories. Montreal Lake sends its samples to ALS Laboratory Group – Environmental Division in Saskatoon where they are tested for a scan of water quality parameters found within the GCDWQ that are of a health concern or may impact the consumer's opinion of water. Monitoring for certain contaminants may only take place once a year because these contaminants simply do no occur in the community's source water (Expert Panel, 2006; Health Canada, 1996). Montreal Lake's annual treated and raw water quality tests were obtained for the years 2006 and 2005. The annual treated water test was also obtained for the year 2004. Results from these tests were then compared to the maximum acceptable concentrations (MAC) and/or aesthetic objectives standards specified by the GCDWQ. Three years of test results also provided a glimpse into the consistency of the drinking water supplied to the community's residents, and the opportunity to identify any changes.

The Montreal Lake Water Treatment Plant Operators are required to monitor bacteriological water quality five times a week by testing for the presence of total coliforms and *E.coli* bacteria. Analysis of these microbiological parameters is conducted onsite using the Colilert® system which is widely used and considered a reliable and appropriate technique by government regulators (INAC, 2006a; Health Canada, 2005b). Along with bacteriological water quality, chlorine residual monitoring is also conducted five times a week by the treatment plant operators. Samples are analyzed for free chlorine and total chlorine residuals. Four weekly water quality monitoring data sheets were obtained, revealing the results of bacteriological and chlorine residual analysis. These data sheets ranged from the week of April 29th, 2007 to the week of June 3rd, 2007 and were selected out of convenience to participants as they were readily available. Although they may not be representative of all times of the year, the small selection of weekly water quality monitoring sheets provides insight into the bacteriological quality and chlorine residual levels of the drinking water provided to the community's residents. Furthermore, these data sheets also give an indication of the diligence applied by the treatment plant operators in their monitoring activities.

Over the past two years, public concern over the effluent discharged from the wastewater lagoon into Montreal Lake has grown among members and band councillors of the Montreal Lake Cree Nation. In particular, residents are apprehensive about the negative effect of insufficiently treated effluent on water quality and the aquatic ecosystem. This concern prompted the community's EHO and water treatment plant operators to take surface water samples following the spring discharge of the wastewater lagoon, and send them to ALS Laboratory Group – Environmental Division where they were analyzed. Results of these samples were obtained and these data provide another measure of surface water quality in Montreal Lake. As the samples were taken on June 14, 2007, approximately two weeks after spring discharge, they should also indicate the lower range of source water quality.

4.1.4 Documents

Document analysis is a popular method in the assessment of capacity and is used mainly to corroborate data from interviews and workshops (Timmer et al., 2007; Brown et al., 2005; Ivey et al., 2004; Pirie et al., 2004; and Durley et al., 2003; de Loë et al., 2002). The types of documents that were reviewed for this study include INAC inspection reports, technical documents pertaining to Montreal Lake's water and wastewater systems, and a range of publications and guidelines from INAC, Health Canada, PAGC, and PWGSC (see Appendix 3 for a list of case study documents). Along with the corroboration of data from other sources, the existence and content of certain documents provided information pertinent to the assessment of the institutional and technical dimensions of capacity.

In order to verify the performance of the Montreal Lake water and wastewater systems, onsite inspections are conducted annually by INAC employees from the North Central District Office in Prince Albert. The updated guide for these inspections is available from INAC (2006a) and covers items such as maintenance project needs, cost information, treatment process performance, certification level of operators, and water quality testing results. In addition to the above areas of review, the annual inspections evaluate the risk level of water and wastewater systems. INAC (2003) established the categories of water source/effluent receiver, design, operational practices, reporting, and operators for risk assessment. These components are individually evaluated based on *Risk Level Evaluation Guidelines for Water and Wastewater Treatment Systems in First Nation Communities*, an internal document developed by INAC in 2005. Risk is ranked numerically by INAC employees from 1-10 for each system component where a ranking of 1-4 represents a low risk, a ranking of 5-7 represents a medium risk, and a risk of 8-10 represents a high risk. Based on the risk levels of all five categories, the overall risk of the system is then determined. The water and wastewater systems inspection reports were obtained for the year 2005. The 2007 water system inspection report, which followed the guidelines found in INAC (2006a), was also obtained. The 2006 inspections were conducted; however the reports were not completed due to a personnel change at INAC's North Central District Office. The inspections reports provide valuable data in the assessment of technical capacity as water system components are examined in detail.

Furthermore, the reports corroborate information from interviews and workshops, and reveal INAC's perception of Montreal Lake's drinking water safety. A copy of the *Risk Level Evaluation Guidelines for Water and Wastewater Treatment Systems in First Nation Communities* was also obtained to permit proper interpretation of the inspection reports.

Additional technical documents were also acquired in the areas of water and wastewater treatment. In terms of drinking water treatment, a US Filter Microfloc® Trident® Water Treatment Systems brochure outlining the capabilities of Montreal Lake's two package surface water treatment units was reviewed. Information on the community's wastewater system was found in Saskatchewan Environment's (2002) *Guidelines for Sewage Works Design* and a project description of the Montreal Lake Cree Nation Lagoon Expansion from Associated Engineering. These documents were used mainly to support the interpretation of technical capacity and corroborate technical data from other sources.

Like many First Nations communities, Montreal Lake lacks particularized documents concerning drinking water management. However, since the First Nations Water Management Strategy was announced in 2003, the federal government has published a set of water quality management standards, protocols, and policies which are applicable to First Nations communities throughout the nation. These documents include INAC (2004), Health Canada (2005b), INAC (2006a), and INAC (2006b). INAC (2004) describes the roles and responsibilities of First Nations, INAC, Health Canada, and

Environment Canada, in providing safe and reliable drinking water and effective wastewater services in First Nation communities. Health Canada (2005b) provides guidance on how to implement the *Guidelines for Canadian Drinking Water Quality* to ensure the safety of drinking water in First Nation communities. INAC (2006a) contains standards for design, construction, operation, maintenance, and monitoring of drinking water systems in First Nations communities while INAC (2006b) serves as a guide to engineers in the preparation of plans and specifications for public water supply systems on First Nations lands. These documents are all intended for use by the various authorities responsible for providing First Nation communities with safe drinking water. Although much of the material was newly generated, parts of these documents were also based on INAC (1998) and INAC (1999) which define criteria for funding available to First Nations water systems. The PAGC has also developed an internal water safety document for their 12 bands titled *Drinking Water Safety Program: Monitoring and Response Protocol*. Their protocol outlines the responsibilities and activities of the management and staff of a First Nations community and Health Canada in the monitoring of drinking water safety. The above documents were all obtained and reviewed. Their primary purpose was to assist in the assessment of institutional capacity.

4.2 Data Analysis

Information from the workshop, interviews, water quality data, and case study documents was analyzed to assess capacity according to the framework I had established. However, the capacity framework was also modified in certain cases to account for important information that emerged and was not covered in the original framework design. For instance, technical capacity was considered separately for the piped and trucked distribution systems due to a significant difference in drinking water safety that was not originally anticipated. The capacity indicators relating to operator certification and federal legislation were also designed after data collection to better reflect drinking water management in the context of a First Nations community.

Any points related to capacity or the specific indicators from all sources were noted and clustered by capacity dimension. Some data were equally relevant to two capacity dimensions. For example, the frequency in water quality monitoring pertains to both human resources and technical capacity. In addition to the presence of information in data sources, the absence of data was also considered. Patterns, or thematic connections, in data were then noted for each indicator to generate meaning as proposed by Miles and Huberman (1994). Most of these patterns were straightforward, such as participants and documents suggesting that operators diligently perform their monitoring activities. Others were more circuitous. For example, the determination on whether funding surpluses were being saved was based on direct information relating to the presence or absence of an annual surplus, crosschecked with documents and interview responses pertaining to the water system funding structure and the status of Montreal Lake’s water system needs (repairs/upgrades) such as the extension of the intake pipe.

To increase confidence in interpretations, I confirmed information across multiple sources where possible (Stake, 1995). Although they were rare and minor to the outcome of the study, certain discrepancies were found between data sources. For example, the number of homes connected to the piped and truck haul distribution systems differed slightly in two interview responses and one inspection report. In this situation as in all others, evidence was weighted using Miles and Huberman (1994) as a guideline to determine stronger data. All materials were checked a minimum of two times to ensure accuracy. The final step of analysis was a consultation of results with study participants.

4.2.1 Capacity Dimensions

Capacity was considered in terms five dimensions: financial, human resources, institutional, social/political, and technical dimensions. This closely followed the structure of Timmer et al. (2007). Building on the rationale of previous research, the five dimensions of capacity examined in this study were selected for the following reasons.

Financial capacity is the ability of a water system to meet the financial obligations required for operation and maintenance at a level that enables it to meet applicable water standards (Brown et al., 2005). In general small community water systems, defined as those systems servicing between 501 and 3,300 people year-round (USEPA, 2006), face considerable difficulties in achieving financial capacity (Brown; 2005; Dziegielewski and Bik, 2004; Maras, 2004; NRC, 1997). The situation is more complex for First Nations water systems in Canada. In particular, due the reliance on federal government for water system finance, source and sufficiency of funding were two key considerations in the examination of Montreal Lake's financial capacity.

In this study, **human resources capacity** refers to the knowledge, dedication, skills, and abilities of individuals engaged in the provision of drinking water. The water system personnel in Montreal Lake include the water treatment plant operators, Band councilors, the environmental health officer, the utilities trainer, and employees of INAC. Competent operators are critically important in the delivery of safe drinking water, whereas capable mangers are a foremost requirement for an efficient water system (Hrudey and Hrudey, 2004; O'Connor, 2002; NRC, 1997; Biswas, 1996). Smaller communities typically do not possess the resources to recruit and retain specialized staff to carry out technical activities (de Loë et al., 2002), and therefore rely on the availability of external specialists to perform these tasks (Timmer et al., 2007). In the case of First Nations communities, these experts are drawn from government agencies, tribal councils, and technical advisory groups. For these reasons the diligence and certification of water treatment plant operators as well as the availability of technical expertise were important issues in the assessment Montreal Lake's human resources capacity.

Institutional capacity describes the legislation, regulation, delineation of responsibilities, protocols, and plans surrounding the provision of drinking water to First Nations communities. Effective institutional arrangements can guide the actions of water system personnel, enabling improved drinking water management and overall capacity as a result (de Loë et al., 2002; Hamdy et al., 1998). Because of the regulatory gap and presence of jurisdictional issues in First Nations drinking water management, the assessment of Montreal Lake's institutional capacity focused on the various structures and processes directing drinking water management and the transparency of roles and responsibilities.

In this study, **social/political capacity** describes the leadership, partnerships, communication, and public awareness in the management of Montreal Lake's drinking water. There are many players involved in First Nations drinking water management from different authority levels, creating an environment where roles and responsibilities are often blurred. Communication among the agencies of different and similar levels is therefore necessary to create partnerships where each is accountable for their duties, and is aware of the accomplishments and struggles of the others. The presence of these well-developed horizontal and vertical linkages is an important component of capacity (Mcguire et al., 1994; de Loë et al., 2002), but has been found to be lacking in First Nations communities (Office of the Auditor General, 2005). The stability of the relationships between INAC, PAGC, the Band Council, and the water treatment plant operators were key points in examination of Montreal Lake's social/political capacity.

Technical capacity can be viewed as the physical and operational ability of a system to provide water that meets the standards of the *Guidelines for Canadian Drinking Water Quality*. The provision of safe drinking water involves technical competence in several areas such as source water, design and treatment, and monitoring. In general, First Nations communities have been and continue to be plagued with poor drinking water quality (Christensen, 2006; Wilson, 2004; INAC, 2004b; Parsons, 2003; NAHO, 2002; O'Connor, 2002), which is illustrated by the reality that as of October 19, 2007, 99 First Nations communities were under a drinking water advisory. Previous studies have determined that this is largely due to deficiencies in source water (Smith et al., 2006; INAC, 2003), design and treatment (Office of the Auditor General, 2005; INAC, 2003), and monitoring (Smith et al., 2006; INAC, 2003; Moore, 1999). Considering the history of technical inadequacy in First Nations water systems, each component was viewed as vital to technical capacity in the Montreal Lake water system. Furthermore, as some homes in the community have piped water while others are on a truck haul system, technical capacity was considered separately for both types of distribution systems to account for this significant difference in water system infrastructure.

4.2.2 Capacity Framework

Montreal Lake's water system capacity was assessed using a framework containing three parts: a capacity indicator rating table, capacity indicators, and indicator questions. The first step in the assessment process was the development of a number of capacity indicators for each capacity dimension discussed in the previous section. Some indicators were taken directly from Timmer (2003), whereas others were adapted from other literature or created to better reflect and examine the particularized context of drinking water management in First Nations communities. The number of indicators used to assess each dimension ranged from a minimum of seven for institutional capacity to a maximum of nine for technical capacity. Indicators were weighed equally in the assessment of each capacity dimension as they were in McGuire et al. (1994). In order for the indicators to be consistently evaluated, indicator questions were used similar to those of Durley et al., (2003) where a positive response generally denoted the presence of capacity (see Appendix 3 for the list of indicator questions). Indicator questions were either adopted from Timmer (2003) or designed to better suit the unique indicators used in this study. Indicators and indicator questions were continuously developed and modified throughout the study to accommodate the research data and unplanned but informative lines of inquiry that were followed. In a sense, the changes to indicators during fieldwork can be considered as part of the adaptive research approach proposed by Reed and Peters (2004). In particular, unexpected findings were viewed as an opportunity to go back to the original set of indicators and make the necessary adjustments for a more accurate capacity analysis (Reed and Peters, 2004; Miles and Huberman, 1994). The final component of the capacity framework, the capacity indicator rating table, was crafted following the collection of data.

The capacity indicator rating table (Table 5.1) was adapted from the *Summary Indicator Table* used in EFC (2005) which lists each factor determining technical, financial, and managerial capacity, and rates them by indicating whether the water system meets, exceeds or does not meet the standard required for each indicator. EFC's (2005) *Summary Indicator Table* was selected as the model for Table 5.1 because it fits a qualitative approach to rating indicators, allows each dimension of capacity to be considered separately, and provides a visual representation of capacity. In addition to the substitution of indicators and capacity dimensions, Table 5.1 differs from EFC's (2005) *Summary Indicator Table* in the number and categories of indicator ratings. Table 5.1

employs a four-level rating scheme where each indicator either meets, somewhat meets, or does not meet the standard, and where applicable, meets and is expected to meet the standard in the future (see Appendix 4 for a thorough explanation of capacity indicator ratings). Building on the responses to indicator questions, capacity is considered absent for an indicator if it does not meet or only somewhat meets the standard, whereas capacity is regarded as present if an indicator meets the standard or currently meets the standard and is expected to do so in the future. A summary of capacity indicator ratings is presented in Table 5.1.

5.0 Results and Discussion

The capacity of Montreal Lake to provide safe drinking water to its residents is dependent on financial, human resources, institutional, social/political, and technical dimensions. These components were defined in Chapter 2 and placed in an evaluative framework in Chapter 4. They are discussed further in this chapter in the specific context of drinking water management in Montreal Lake. The main focus of this chapter however is to provide the rationale behind the capacity indicator ratings presented in Table 5.1.

Table 5.1 Capacity Indicator Ratings

Indicator	Rating			
Legend (-) indicator does not meet standard (+/-) indicator partially meets standard (+) indicator meets standard (→) indicator meets standard and is expected to in the future	Capacity Absent		Capacity Present	
	-	+/-	+	→*
Financial Capacity				
Funding is available for operation and maintenance				●
Funding is sufficient for operation and maintenance				●
Funding is available for infrastructure and water system projects				●
Funding for water system is stable				●
Funds are generated within the community	●			
Funds are generated outside the community				●
Water rates for customers reflect the cost of providing drinking water (treatment, distribution, maintenance)	●			
Funding surpluses are saved for future water system requirements		●		
Human Resources Capacity				
Departments responsible for providing drinking water have a sufficient number of employees dedicated to water management			●	
Departments responsible for providing drinking			●	

water have diligent personnel to adequately operate and maintain the system				
Departments responsible for providing drinking water have certified personnel to adequately operate and maintain the system		●		
Departments responsible for providing drinking water have access to individuals with the necessary skills and training to manage drinking water			●	
Departments responsible for providing drinking water have access to individuals with the expertise needed to undertake technical activities related to drinking water quality			●	
Education and training opportunities are available to staff members from departments involved in providing drinking water			●	
Education and training opportunities are regularly taken up by staff members from departments involved in providing drinking water			●	
Institutional Capacity				
Federal legislation provides guidance for the provision of safe drinking water in the community	●			
Federal policies provide guidance for the provision of safe drinking water in the community				●
Federal legislation provides guidance for the roles and responsibilities of players involved in the provision of safe drinking water	●			
Federal policies provide guidance for the roles and responsibilities of players involved in the provision of safe drinking water in the community				●
Plans have been developed to guide community actions for regular provision of drinking water				●
Plans have been developed to guide community actions during water quality emergencies				●
A source water protection plan has been developed	●			
Social / Political Capacity				
Clear leadership (clear delineation of responsibilities) for the provision of safe drinking water in the community exists			●	

Active linkages between community and tribal council departments exist (vertical linkages)			●	
Active linkages between community and federal government departments exist (vertical linkages)		●		
Active linkages between tribal council and federal government departments exist (vertical linkages)		●		
Active linkages between community departments and community councils exists (horizontal linkages)			●	
Community awareness and concern for water quality management has been developed		●		
Community members are regularly involved in decisions pertaining to the management of drinking water		●		
^Technical Capacity – Piped Distribution System				
Community drinking water quality currently meets drinking water standards			●	
Community drinking water quality is monitored regularly (daily tests)		●		
Community drinking water quality is monitored regularly (weekly and quarterly tests)			●	
Community drinking water quality is monitored regularly (annual tests)			●	
Physical infrastructure is adequate to produce safe drinking water for the community's residents		●		
Physical infrastructure is adequate to distribute safe drinking water to the community's residents				●
Source water adequacy in terms quantity				●
Source water adequacy in terms of quality			●	
Potential water supply contaminant sources (point and non-point) have been identified			●	
^Technical Capacity – Truck Haul System				
Community drinking water quality currently meets drinking water standards	●			
Community drinking water quality is monitored regularly (including daily tests)		●		
Community drinking water quality is monitored regularly (including weekly and quarterly)		●		
Community drinking water quality is monitored regularly (annual tests)			●	
Physical infrastructure is adequate to produce		●		

safe drinking water for the community's residents				
Physical infrastructure is adequate to distribute safe drinking water to the community's residents	●			
Source water adequacy in terms quantity				●
Source water adequacy in terms of quality			●	
Potential water supply contaminant sources (point and non-point) have been identified			●	

* The arrow (→) rating may not be applicable or possible for some indicators. The arrow (→) column has been shaded where the estimation of future conditions is not possible, and has a diagonal line pattern where future conditions are not applicable. .
^ Technical Capacity is considered in two separate categories, piped distribution system and truck haul system, due to the significant differences that exist between the indicator ratings of these water delivery systems.

5.1 Financial Capacity

The financial capacity of the Montreal Lake water system has been defined in this study as its ability to meet the financial obligations required for operation and maintenance at a level that enables it to meet safe drinking water guidelines. It is widely documented that in general, small community water systems face considerable difficulties achieving financial capacity. The financial situation in the First Nations context is more complex as funding is provided almost entirely from the federal government, creating a reliance on sources outside the communities. For these reasons, the adequacy and source of funding were considered to be key issues in the assessment in financial capacity. In total, eight indicators were used in the financial evaluation of Montreal Lake's water system and were subdivided into three categories: (1) four indicators dealt with the adequacy, sufficiency and stability of funding, (2) three indicators focused on the source of funding, and (3) one indicator examined funding surpluses. It should be noted that a robust assessment of the Montreal Lake water system finances is beyond the scope of this research. However, the investigation of primary financial components permits an assessment of whether Montreal Lake's financial situation is an enabling or impeding factor in the provision of safe drinking water, which is the ultimate objective of a capacity approach.

5.1.1 Availability, Sufficiency, and Stability of Funding

As indicated earlier, the federal government has a clear mandate and fiduciary responsibility to ensure a level of drinking water safety for First Nations communities comparable to that of people who live off reserves. As such, First Nations are assured funding from Indian and Northern Affairs Canada (INAC) and Health Canada for capital construction and upgrading, operation and maintenance, water and wastewater plant operator training and certification, and monitoring (INAC, 2004). In recent years the federal government has made drinking water safety in First Nations community a priority, which is illustrated by its approval in 2003 of a $1.6 billion budget over five years for the First Nations Water Management Strategy. However, the Expert Panel (2006) demonstrated that the federal government has never provided enough funding to First Nations to ensure that the quality of their water systems was comparable to that of off-reserve communities. In particular, the Expert Panel (2006) noted that funds earmarked for investment in First Nations water systems in the five-year capital covering 2002-2007 turned out to be one-third to one-half of what was actually needed. Similarly, the Office of the Auditor General (2005) previously observed that despite hundreds of millions of dollars spent on water systems between 1995 and 2001, the risk level of drinking water in First Nations communities remained substantial.

There is no question that many First Nations water systems have been and continue to be under-funded, but financial strains are not an issue in the case of Montreal Lake. The community appears to have stable access to sufficient funds for capital, operation and maintenance, staffing, and monitoring costs. In terms of capital construction, INAC funds 100% of the costs of water and wastewater projects in Montreal Lake as it does in all other First Nations communities (Expert Panel, 2006; Office of the Auditor General, 2005). In Montreal Lake, INAC previously financed the development of the water treatment plant and sewage lagoon in 1993. The water treatment plant and all systems, including the water mains, intake, raw water pumping station, underground infrastructure, were built from the ground up and were later upgraded in 1997. In 2004, INAC upgraded the plant once again by doubling the capacity of the reservoir and treatment units. Furthermore, to accommodate the growing population within Montreal Lake, INAC will be constructing a new subdivision holding 238 lots, complete with water and sewer mains, service connections to houses, fire hydrants, a second reservoir and pumphouse, a new lift station for sewage, and a new lagoon. The project's estimated cost is $6.5 million and will take two years to complete beginning in the 2007-2008 fiscal year. Although both the Expert Panel (2006) and the Office of the Auditor General (2005) noted capital shortfalls and undersized systems in communities of rapid population growth, Montreal Lake has had sufficient funding for capital construction costs in the past and will also have financial support to upgrade their water system to accommodate population growth in the future. By almost all accounts, the community's water treatment plant and other water system infrastructure is completely up to date and modern. The one exception is the presence of a truck haul system servicing the 86 outlying homes from the community core. Although 36 of these homes were to be hooked up to the piped distribution system in 2007, it is unlikely that all homes will be connected due to the large distances between certain homes and the high costs associated with the underground infrastructure. The deficiencies of the truck haul system will be discussed further in Section 5.5.

In most First Nations communities, once a water system is running, INAC funds 80% of the operation and maintenance costs with the community responsible for the remaining 20%. However, in Montreal Lake, INAC funds 100% of the operation and maintenance costs. Operation and maintenance funding for the water system is based on the Capital Asset Inventory System (CAIS) which is a module of INAC's Capital Asset Management System (INAC, 1998). The CAIS is formula driven where all assets in a community are numbered, coded, sized, unit priced, and given city centre and remoteness indices (PWGSC, 2005). The city centre and remoteness indices are all derived from Toronto as being 1, and then work outwards in an increasing fashion throughout the nation to each province and each city and finally into remote areas. The rationale for this approach is that the operation and maintenance of an item becomes more costly as communities become further isolated, and therefore funding must be adjusted to account for the elevated costs. Montreal Lake's water system assets include the water treatment plant, lagoon, water trucks, lake intake building, and piped distribution system among others. As mentioned earlier, the community receives a total $156,700 each fiscal year to operate and maintain the water and wastewater system. As an example of the itemized funding system described above, the lake intake building is allocated $581.14 annually.

In addition to the annual operation and maintenance costs of the water and wastewater system, INAC also finances the salaries of water treatment plant operators. Montreal Lake is furnished with the resources to hire a primary full time operator and a part time backup operator. Finally, INAC funds the PAGC to run the Circuit Rider Training Program which provides site specific training and technical assistance to the community's water treatment plant operators. The Circuit Rider Training Program is the main support available to First Nations operators and will be discussed further in Section 5.2.

The monitoring costs of drinking water in First Nations communities are funded by Health Canada under the Drinking Water Safety Program (DWSP). In Montreal Lake, Health Canada has very little visible presence as their departmental activities and responsibilities have been transferred to the PAGC. Health Canada finances the PAGC to hire environmental health officers for quality assurance and quality control of the water samples and provides the funding for the chemicals and equipment used for water quality monitoring. In the event that PAGC employees have concerns with the water system, they will usually request additional funding to address the situation. Finally, Health Canada also funds the salaries of community-based water quality monitors. Montreal Lake does not have a community-based water quality monitor and instead the water treatment plant operators perform these duties.

Based on the financial information pertaining to the Montreal Lake water system, it was determined that funding is available, sufficient, and stable to cover capital, operation and maintenance, staffing, and monitoring costs. Where the Expert Panel (2006) noted the presence of capital shortfalls, Montreal Lake seems to have modern infrastructure and adequate resources to accommodate population growth and subsequently upgrade the water system. Also, during public hearings, the most insistent theme brought to the attention of the Expert Panel (2006) by First Nations was the inadequacy of financial resources to run water and sewage systems. However, in Montreal Lake funding for operation and maintenance, staffing, and monitoring also appears to be sufficient as financial pressures were not cited at all during fieldwork as areas in need of improvement. Participants suggested that additional funds could be made available upon request for operation and maintenance needs, and that the current funding scheme was generous for staffing purposes. Montreal Lake's funding was also considered to be stable as the Band receives its support on a monthly basis. For these reasons, the four indicators pertaining to the availability, sufficiency, and stability of funding were all rated to reflect the presence of financial capacity.

5.1.2 Source of Funding

In general, the economic capacity of First Nations limits their abilities to self-finance basic services such as education, healthcare, and the provision of drinking water. Low or uncertain incomes are characteristic of many communities including Montreal

Lake where government transfers accounted for 40.1% of income in 2000 (Expert Panel, 2006; Statistics Canada, 2002). Without the capacity to raise their own revenues, most First Nations communities must rely on funding from the federal government to finance their water systems. This is also true in the case of Montreal Lake, as funding for the water system is provided entirely from sources outside the community, which was illustrated in the previous section. It was also mentioned earlier that INAC's policy, according to guidelines found in INAC (1998), is to fund 80% of the estimated operation and maintenance costs for a particular water system, leaving the First Nations Chief and Council responsible for the remaining 20% through user fees or other revenue sources (Expert Panel, 2006; Office of the Auditor General, 2005; INAC, 2004). The Expert Panel (2006) noted that for many First Nations, finding the funds to cover the portion of operation and maintenance costs not provided by INAC is a serious hardship. Furthermore, the Office of the Auditor General (2005) revealed that very few First Nations, including Montreal Lake, collect user fees, which are critical in recovering costs associated with operating and maintaining water system infrastructure.

The fact that there is no charge for water in Montreal Lake may reflect the overall economic context of the community. Recent research has indicated that current water pricing in Canada harms many low-income households (Renzetti, 2006). Reforming user fees or water rates has recently become an area of interest in water management, and is beginning to receive widespread attention in both the academic and public sector settings (Brown, 2007; Renzetti, 2006). The current fee structure throughout most of Canada creates a variety of problem including over-consumption and deteriorating infrastructure

(Renzetti, 2006; Brandes et al., 2005). Specifically, present prices do not reflect the full cost of providing water and therefore revenues are insufficient to meet all the operating and capital needs of water suppliers (Brandes et al., 2006; Renzetti, 2006). However, even when water is priced appropriately in rural communities of similar populations to Montreal Lake, obtaining adequate revenue to self-finance infrastructure and operation needs is not feasible due to the undersized ratepayer base and low average incomes (CCME, 2004; Maras, 2004; WCI, 2003; NRC, 1997). Residential water-use is also not metered in Montreal Lake. The installation of metres is considered to be a first step in residential water management, enabling water systems to measure the amount of water used and identify excessive use (Brandes et al., 2005). Although water conservation and efficiency may not be pressing issues in the community, the presence of metres also allows a volume-based pricing structure to be put in place. The impacts of volumetric rate structures on low-income households are still unclear, but it is believed that they are favourable compared to those of non-volumetric and constant rate structures (Renzetti, 2006). In any case, if user fees were ever to be collected in Montreal Lake, they would only be required to cover 20% of the annual operation and maintenance costs as per INAC policy. This would allow the pricing structure to be adjusted to better suit residents.

The current financial circumstances where INAC and Health Canada fund 100% of water system costs in Montreal Lake may suggest that there is very little need for the community to begin collecting user fees to self-finance a portion of expenses. However, a reliance on external support also means that financial matters pertaining to drinking water are outside of the community's control. Because operation and maintenance activities are largely dependent on financial resources, a reliance on outside funding also limits the community's ability to determine, for itself, how to organize and run the water system (Expert Panel, 2006). Even though funding is believed to be adequate in Montreal Lake, a self-financed water system is the only guaranteed method for the community to ensure that sufficient funds are available when required (CCME, 2004). Self-sufficiency, therefore, is the ideal situation for a community water system. Still, this is not always possible and in Montreal Lake, like many other First Nations communities, the economic reality is that the current reliance on the federal government will continue in the near term (Expert Panel, 2006). For these reasons, the absence of funding generated from within the community was viewed as a deficiency in financial capacity. Likewise, the lack of user fees to cover a portion of water system costs was also considered a shortcoming. Consequently both indicators pertaining to these areas were rated to reflect shortages in Montreal Lake's financial capacity.

It should be restated here that difficulties financing water system costs are in no way restricted to First Nations communities. In fact, small systems across Saskatchewan, Canada, and beyond struggle to raise funds for a safe water supply service (SWA, 2002; NRC, 1997). Furthermore, a reliance on external funding is also not unique to First Nations water systems as provincial and federal governments subsidize urban water and wastewater infrastructure across Canada (Brandes et al., 2005). Considering the widespread water infrastructure deficit in Canada of $31 billion, First Nations communities like Montreal Lake may actually be in a favourable position in terms of funding arrangements when compared to non-First Nations communities (Mirza, 2007). Montreal Lake's entire water infrastructure is modern, and funding is assured to be available from the federal government on an annual basis. The community is also not required to apply for external support, which was demonstrated by Jocoy (2000) to be a time consuming and specialized process that small communities are often incapable of performing. For these reasons, Montreal Lake's access to funding generated outside the community was viewed as a presence of financial capacity and its indicator was rated accordingly. In a sense, the two indicators pertaining to the source of funding cancel each other out in this study because all funding is provided from outsides sources. However, the indicator pertaining to user fees places additional importance on financing water system costs from community generated funds. The federal government may be the most reliable backer possible, but self-financing water systems hold added assurance that funds are available when required. For instance, the federal government has made drinking water safety in First Nations communities a priority, but funding and policies may be subject to change in the future.

5.1.3 Funding Surpluses

As discussed earlier, under INAC's current funding arrangement for operation and maintenance costs, each water system component is allotted an annual amount based on a formula. To take the example of the Montreal Lake intake pipe, $581.14 is earmarked each year for its upkeep. INAC assumes that the intake pipe, along with many other water system components, will not require repairs or upgrades on an annual basis. Therefore, in the case of the intake pipe, the entire $581.14 will not be needed each year for operation and maintenance. Conversely, there will no doubt come a time when a major upgrade or repair is required that is more costly than the allotted annual amount. Despite this notion, INAC's policy is to finance the intake pipe at a constant rate rather than providing extra or holding back funds when appropriate. The rationale behind this funding structure is for Montreal Lake to accumulate financial surpluses in years where major operation and maintenance are not required. By doing so, funds will be immediately available to the community for repairs or replacement in the event of a break or component failure. The presence of reserve funds is considered to be critical to developing financial capacity as it helps water systems through difficult periods and emergencies (USEPA, 2006; Dziegielewski and Bik, 2004).

Despite a funding structure in place that encourages setting aside reserve funds, the Montreal Lake water system does not maintain an annual fiscal surplus. Funding for operation and maintenance is given on a monthly basis to the band council who then provide the water treatment plant operators with their budget. Under current funding conditions, First Nations have the flexibility to use operation and maintenance funds for other purposes outside of water provision (Office of the Auditor General, 2005; INAC, 1998). Specific challenges related to this funding scheme, such as councils giving a low priority to water issues, remain and are well known among First Nations and the federal government (Expert Panel, 2006). However, a thorough examination of the use of operation and maintenance funding was beyond the scope of this study. Instead, the main point of interest was whether reserve funds exist to finance unforeseen repairs or address water system emergencies.

The absence of reserve funds in Montreal Lake has not led to any serious water system needs being neglected, but there are some current issues that would have been addressed if a surplus had been set aside. For example, Montreal Lake's water treatment plant operators began to notice in the summer of 2006 that the lake intake pipe was picking up sediment and garbage which can clog the collector pipe and pumps (PWGSC, 2000a). It was determined that raising the intake pipe's position by 6 inches would solve the problem and the repair was brought to the attention of INAC. As this is considered to be a small job, INAC's policy is to turn back to the band and explain that they receive annual funding for maintenance for these purposes. Therefore, it is the responsibility of Montreal Lake to hire a contractor to raise the intake pipe or undertake the task itself. As of September 2007 the lake intake pipe had not been raised. Although the intake pipe may not be considered a serious health risk, available reserve funds would speed up the repair process considerably and allow this water system issue to be addressed immediately. A funding surplus would also allow the community's water treatment plant operators to install features that improve water service. Specifically, the distribution system could profit from 15 new close valves and the replacement of 20 curb stops. This would minimize water service disruption during the event of a water main break and facilitate the repair and cleaning of water lines. Without reserve funds though, these upgrades will have to wait.

Even though a funding surplus does not exist in Montreal Lake, participants suggested that INAC would provide extra funding in the event of an urgent infrastructure replacement need. Furthermore, it was also conveyed that if a water system issue posed a health risk, additional funds would be granted to resolve the problem. For example, if a cistern became badly damaged and needed to be replaced, INAC would cover half the cost leaving the band responsible for the rest. Financial concerns were not mentioned by participants during fieldwork despite it being evident that Montreal Lake does not save money for any future system requirements. It is assumed that if emergency funding was required it could be obtained. Nevertheless, the absence of reserve funds was viewed as a deficiency in Montreal Lake's final capacity. The issue of the intake pipe illustrates the usefulness of having a funding surplus for the water system. However, as additional funds would become available in the events of health risks or urgent replacement needs, the indicator pertaining to a financial surplus was rated as somewhat meeting, rather than not meeting, the capacity standard.

5.2 Human Resources Capacity

This study considered Montreal Lake's human resources capacity as the knowledge, dedication, skills, and abilities of the individuals engaged in the provision of drinking water. The competency of operators and the support they receive from managers, external agencies and the general public are widely recognized as critical elements of a safe water system. Unfortunately for residents of First Nations communities, human resources capacity has been a major source of concern in the past.

In particular, these systems have been characterized by a lack of certified water treatment plant operators and fragmented technical assistance and training (Smith et al., 2006; Office of the Auditor General, 2005; INAC, 2003; Holden, 1999; Moore, 1999). On account of these well-known deficiencies, the centre of attention was placed on the diligence of operators and the technical support that is available to them in the assessment of human resources capacity. Seven indicators were used in the examination of Montreal Lake's human resources of which three related to the water system personnel within the community, two focused on external support, and the final two were concerned with education and training opportunities. The ratings for these indicators, found in Table 5.1, are explained below.

5.2.1 Water System Personnel

In 2001, INAC undertook a comprehensive on-site assessment of water and wastewater systems in First Nations communities. Along with performance and operating practices, the inspections considered operator qualifications such as training, certification and experience. Of the approximately 1,200 operators who work in First Nations water and wastewater facilities, the assessment determined that only 10 percent met the industry certification requirement of their respective province (Office of the Auditor General, 2005; INAC, 2003). Perhaps even more troubling was the indication that approximately 35 percent of operators had not received some form of training on how to operate their systems (INAC, 2003). Finally, INAC (2003) also listed the unavailability of backup operators as a common deficiency. Recognizing the important role that system operators play in the operation and maintenance of water systems, INAC and Health Canada made training and certification of operators one of the seven primary elements of the FNWMS (Office of the Auditor General, 2005; INAC, 2004).

Although there remains some variation across Canada, it is increasingly becoming a requirement that operators are certified to the level of training they have achieved (Expert Panel, 2006). The certification of on-reserve operators is based on standard examinations that match the requirements of the applicable provincial system (Expert Panel, 2006; INAC, 2006a). As water systems vary in complexity based on components such as treatment technology, distribution, and source water, operators are required to be certified to the same class or higher than the class of the system they operate. Table 5.2 displays the education and job experience requirements for Saskatchewan water system operators as outlined in INAC (2006a). Essentially, an operator must advance through a step-by-step certification process (Expert Panel, 2006). The first phase is Operator in Training which requires a Grade 10 education or its equivalent, and 6 months of experience. From there, an operator must achieve Class 1 certification to run the most basic water system technology (Expert Panel, 2006). Depending on the complexity of an operator’s treatment plant, further levels of certification, reaching up to Class 4, may be required.

Each level of certification requires the operator to pass an exam and put in a specified number of annual training hours and on-site work experience (Expert Panel, 2006). Training hours increase at each certification level and consist of continuing education in the form of courses and workshops and specific on-site training (Expert Panel, 2006). Montreal Lake's water treatment plant is considered a Class 2 system,

Table 5.2 Saskatchewan Operator Certification Requirements

Pre-requisites: Grade 10 (or GED 10), or Grade 12 (or GED 12), or combination of experience and training (see tables).
Length of program: Varies by level
Method of delivery: Accredited college
Certifications provided: Small Systems, Classes 1, 2, 3, and 4

Pre-requisites: Operator-in-training and Small Systems

Category	Education	Experience
Small water system (SWS)	Grade 10 or GED 10	6 month of experience
Small wastewater system (SWWS)	Grade 10 or GED 10	6 month of experience

Pre-requisites: Classes 1, 2, 3, and 4

Category	Class 1		Class 2		Class 3			Class 4		
	Educ.	Exp.	Educ.	Exp.	Educ.	Exp.	DRC	Educ.	Exp.	DRC
Water treatment (WT)	12	1	12	3	14	4	2	16	4	2
Water distribution (WD)	12	1	12	3	14	4	2	16	4	2
Wastewater treatment (WWT)	12	1	12	3	14	4	2	16	4	2
Wastewater collection (WWC)	12	1	12	3	14	4	2	16	4	2

Notes:
-GED = General Education Diploma
-CEU = Continuing Education Unit
-DRC = Direct responsible charge
-Education of 14 years means Grade 12 or GED 12 plus 2 additional years of education.
-In cases where an operator is required to have four years of operational experience, two of those years must be in a direct responsible charge (DRC) position.

Source: Indian and Northern Affairs Canada. 2006a. *Protocol for Safe Drinking Water in First Nations Communities*. Gatineau, Quebec: Indian and Northern Affairs Canada.

which means that its operator must have a Grade 12 education or its equivalent, and 3 years of experience as pre-requisites for certification.

The Expert Panel (2006) and the Office of the Auditor General (2005) noted that meeting the certification requirements are often a challenge for operators of small systems. In fact, even finding qualified people in small and remote communities to enter the training regime can be difficult (Expert Panel, 2006; Braden and Mankin, 2004; NRC, 1997). Once trained, retaining operators can be just as challenging as small communities may not be able to compensate water system personnel to a level comparable to opportunities elsewhere (Expert Panel, 2006; Dziegielewski and Bik, 2004; Maras, 2004; NRC, 1997). Furthermore, Smith et al. (2006) noted that the cultural and political environment of First Nations communities may also negatively impact the selection of water system operators. In particular, operators may be chosen for other reasons than their qualifications or interest in the work, including their relation to members of the Band Council or because they are already involved in another aspect of public works (Smith et al., 2006). This type of selection means that operators may change with the Band Council, leading to additional difficulties in retaining trained and/or experienced operators (Smith et al., 2006).

Montreal Lake's community-based water system personnel consist of two water treatment plant operators, a part-time manager, and by extension, two water truck drivers. In contrast to the majority of First Nations communities who face considerable challenges finding suitable staff, Montreal Lake appears to have a very diligent and complete human resources component to their water system. As mentioned in the financial capacity section, INAC currently funds the salaries of the full-time primary and part-time backup water treatment plant operators in the community. The backup operator is actually a full-time employee of the water system as there are no water quality technicians/community-based water quality monitors in the community; the normal duties of water quality technicians and monitors are performed by the water treatment plant operators. The presence and availability of a backup operator was considered to be a significant strength of Montreal Lake's human resources capacity. Many First Nations water systems lack a backup operator whose involvement and experience provides assurance that the water system will be operated properly in the absence of the primary operator (INAC, 2003).

Montreal Lake's water treatment plant operators are supervised by a part-time manager who is also the Band Councillor in charge of community infrastructure. The manager provides leadership for drinking water management in Montreal Lake and is very knowledgeable of the community's water system. Lastly, Montreal Lake also employs two water truck drivers. During the fieldwork phase of this research, the community's two trucks delivered water to 86 homes, although 36 of them were to be connected to the piped distribution system at some point during 2007. INAC (2006a) noted that technical requirements for trucked water systems, including a truck operator certification process, are currently being developed for First Nations. These requirements would be a welcome addition to any trucked water distribution system as additional potential for contamination compared to the piped distribution system exists in the loading, transport, and unloading stages of trucking water (Expert Panel, 2006). As a unit, it was determined that the primary and backup operators, part-time manager, and water truck drivers are a sufficient number of personnel dedicated to water management. An adequate amount of employees was viewed as a presence of human resources capacity and its indicator was rated accordingly.

For the most part, the water treatment plant operators are very diligent in their monitoring, operation, and maintenance activities. Several participants suggested that the operators were very industrious and were key factors in the provision of safe drinking water within the community. In particular, it was noted that the operators stay on-top of any water system issues and are continually aware of any potential threats that may affect water quality. The operators also adequately perform the required weekly bacteriological and chlorine residual monitoring activities which were mentioned in the 2005 INAC water system inspection report. However, the 2007 INAC water system inspection report revealed that 172 days of missing turbidity records were not properly explained by the operators. In addition, no records were kept of the system's high turbidity, its main operational problem. High levels of turbidity do not necessarily translate into unsafe drinking water, but they can interfere with water treatment, thereby increasing the potential of microbiological threats (CCME, 2004). The turbidity problem of the Montreal Lake Water Treatment Plant will be discussed further in Section 5.5.

Based on responses from participants and comments in inspection reports, it was determined that overall, the operators in Montreal Lake perform their duties in a diligent manner. Unlike the majority of First Nations operators portrayed by Smith et al. (2006), the primary and backup operators in Montreal Lake understand their high level of responsibility and the consequences to community members should they fail in any aspect of their position. The operators are also genuinely interested in the work and perform additional activities, such as monitoring of source water, to respond to any concerns of community members. For these reasons, the indicator related to the performance of water system personnel was rated to reflect the presence of capacity.

At the time of the study, the primary and backup operators were not certified to the level of the Montreal Lake's water treatment plant. The primary operator was certified to Class 2 Water Distribution, Class 1 Wastewater Treatment, and Class 1 Wastewater Collection under the Saskatchewan Water and Wastewater Works Operator Certification Standards, 2002, but only to Class 1 Water Treatment, one level below Montreal Lake's water treatment rating of Class 2. It was noted by participants and the 2007 INAC inspection report that certification at Class 2 was expected in September of 2007 as the primary operator had passed the certification exams and was in the process of fulfilling the required hours of on-site experience. However, as of March 2008 the primary water treatment plant operator had still not been certified, although the application for certification had been submitted to the Saskatchewan Water and Wastewater Association for review. The fact that neither operator was certified to the level of the treatment plant during fieldwork was viewed as a deficiency to Montreal Lake's human resources capacity. However, because the primary operator had passed Class 2 exams, been trained at that level, and was to be certified in the near future, the capacity indicator was rated as somewhat meeting the certification standard.

5.2.2 Access to Experts, Outside Support

As mentioned earlier, small communities tend to lack highly specialized water system personnel and therefore rely upon the availability of external specialists to perform certain tasks. This practice likely represents a more sensible use of community resources as hiring consultants when needed is considerably cheaper than keeping all the necessary experts on staff (de Loë et al., 2002). The situation is slightly different in First Nations communities. Some technical activities may be provided at no cost from federal agencies and tribal councils, whereas others may require the hiring of private contractors. For example, Montreal Lake's operators may request assistance from PAGC engineers to diagnose and address any operational problems with water treatment, but are required to hire a contractor to repair components the water system such as the intake pipe. Regardless of the type, available external support is a crucial component of First Nations water system capacity (Office of the Auditor General, 2005).

The main type of external support available to First Nations water systems comes from the Circuit Rider Training Program (CRTP) funded by INAC (Expert Panel, 2006; Office of the Auditor General, 2005; Edwards, 2001). A primary objective of the CRTP is to certify operators to the level of their water treatment plants. The CRTP was based on the Saskatchewan Water Corporation's Training Program and was officially endorsed across Canada by the Department of Indian Affairs in 1996 (Holden, 1999). As part of this program, First Nations operators receive hands-on, on-site training on a cyclical basis over a period of 12-24 months from experienced operators (Office of the Auditor General, 2005; Edwards, 2001). Stemming from the success of Saskatchewan Water Corporation's training program, the CRTP has been recognized as an effective method of addressing operational problems at both water and wastewater facilities (Holden, 1999). The knowledge and skills of operators have also increased and consequently improvements to drinking water quality are gradually being noticed (Office of the Auditor General, 2005; Holden, 1999). Then again, the support from the CRTP is not accessible to all First Nations and in most cases is not adequate to provide as much assistance as operators would like (Expert Panel, 2006; Office of the Auditor General, 2005).

Further sources of external support available to First Nations water systems are tribal councils and other First Nations organizations (Office of the Auditor General, 2005). INAC funds these groups to make a range of technical services available to communities (Office of the Auditor General). However, not all First Nations are members of a tribal council, and other support organizations are not present in all regions. Moreover, when present, these groups are not required to provide assistance in the provision of drinking water (Office of the Auditor General, 2005).

The shortcomings of the CRTP and other sources of external assistance led the Office of the Auditor General (2005) to conclude that support and therefore capacity development, were fragmented and not available to all First Nations. An underlining theme of the inadequate support structure that should be noted is the contribution of isolation. Many First Nations communities across Canada are located in remote and semi-remote locations. This means that they can only be accessed via a long road trip, or a combination of air in the summer and snow roads in the winter (Expert Panel, 2006; Holden, 1999). Therefore, isolation may significantly hinder the ability of an external specialist to reach a community and provide support. The cost of bringing in a private contractor for repairs is also exponentially more expensive in remote locations (Holden, 1999).

In terms of receiving external support, Montreal Lake is in a very fortunate position due to its easily accessible location. The community is situated in north-central Saskatchewan, just outside the eastern boundary of Prince Albert National Park; the heart of the province's most popular four-season tourist destinations. Montreal Lake can be accessed year-round by a gravel road that branches off a major provincial highway. Distances to the nearest major cities are also relatively minor as Saskatoon (pop. 202,340) is approximately 235km south, while Prince Albert (pop. 34, 138) is only 93km south (Statistics Canada 2007b; Statistics Canada, 2007c). Most of Montreal Lake's external support comes from experts based in Prince Albert, which allows a response time of approximately 1 hour. Considering the difficulties faced by many First Nations communities in receiving external support, the proximity of experts to Montreal Lake is a significant strength to human resources capacity.

As mentioned above, most of the experts available to Montreal Lake are based out of Prince Albert, a distance of 93 km along a major provincial highway. Prince Albert is home to PAGC Engineering Services, PAGC Health and Social Development, and the North Central District Regional Office of INAC. It should be explained that in this study, a distinction was made between individuals with the necessary skills and training to manage drinking water and those with the expertise needed to undertake technical activities related to drinking water quality. Expertise in drinking water management refers to the overall design, plans, and specifications of the water system as well as, when needed, the ability to solve problems in these areas. Technical activities related to drinking water quality include adjusting treatment processes, monitoring specific water quality parameters, interpreting water sample results, and acquiring and analyzing hydrological data. Both types of expertise were considered to be of equal importance in the provision of safe drinking water to the residents of Montreal Lake.

The two PAGC offices provide support for the technical activities related to drinking water quality. Assistance comes from utilities trainers and an environmental health officer. The utilities trainers are funded by INAC to provide Montreal Lake's water system personnel with hands-on support in the operation of the system. For example, in August 2007 a PAGC utilities trainer visited the community and with the primary water treatment plant operator, decided to cut off the polymer coagulant due to address the high turbidity levels. Support provided from the utilities trainers is a component of the CRTP. The environmental health officer is mainly responsible for setting up a monitoring program, interpreting results, and training the operators on how to take certain samples. To respond to growing public concern about lagoon effluent seeping into Montreal Lake, the environment health officer brought a surface water sampling kit to operators in June 2007. During this visit, operators were also instructed on how to sample for trihalomethanes in the distribution system. The utilities trainers and environmental health officer are regular visitors of the community and are readily available when requested.

The regional INAC office provides Montreal Lake with expertise in drinking water management. Employees include a project technologist and a capital/environmental officer. Their main duties are to design and inspect all aspects of the drinking water system, and when necessary provide advice to address any safety issues. During fieldwork, the regional INAC office was in the process of creating an inter-environmental team specifically responsible for conducting regular inspections of First Nations water systems and reporting on progress. The first of these inspections in Montreal Lake took place at the end of August 2007.

Other sources of support that may be periodically required in Montreal Lake are Saskatchewan Environment and private contractors. In the event of surface water quality issues, hydrologists or water resource technicians from Saskatchewan Environment will become involved as the Montreal Lake watershed is not completely on reserve land. Saskatchewan Environment will be contacted by either the PAGC environmental health officer or utilities trainer in these situations. When Montreal Lake's water system is in need of repairs or new infrastructure, the community is required to contract a private firm. As Holden (1999) noted, the cost of bringing in a private contractor can be very expensive in First Nations communities. Fortunately, Montreal Lake is located within an hour of Prince Albert which has many available contractors. The community's wastewater lagoon was designed and constructed in 1993 by Associated Engineering; a firm with offices in Prince Albert and Saskatoon that offers customized services to public sector clients like Montreal Lake in rural areas across Canada (AE, 2007).

The availability of external support for Montreal Lake's drinking water system was considered a major strength to human resources capacity. Experts in both drinking water management and technical activities related to water quality are easily reached through INAC and the PAGC. Consequently both indicators pertaining to the community's access to specialists in these areas were rated to reflect capacity.

5.2.3 Education and Training Opportunities

In the previous section, the CRTP was identified as the main type of external support available to operators of First Nations water systems. As the CRTP is an on-site and hands-on training program, it also represents the main continuing education and training opportunity provided to operators in First Nations communities. Although the adoption of the CRTP has resulted in overall increased knowledge and skills, drawbacks exist in its limited accessibility and usefulness (Expert Panel, 2006; Office of the Auditor General, 2005; Holden, 1999).

The CRTP available to Montreal Lake's operators is funded by INAC and supplied by the utilities trainers at the PAGC. The training component of the CRTP, the provision of on-site assistance to Montreal Lake's operators, was discussed above and viewed as a strongpoint of human resources capacity. The utilities trainers are regular visitors to the community and work with the operators to improve treatment processes. The PAGC also provides the education element of the CRTP, which is necessary to certify operators to the level of their plants. In particular, the PAGC offers several courses to ensure that the continuing education units are available. Most of these courses are offered off-site in Prince Albert, La Ronge, or Saskatoon. The Saskatchewan Water and Wastewater Association also offers several workshops throughout the province that Montreal Lake's operators could attend to increase their certification levels.

The presence of education and training opportunities was viewed as a presence of human resources capacity. The majority of these opportunities are offered directly from the PAGC, which has a strong relationship with the community of Montreal Lake. During fieldwork it was evident that education and training events were being taken up as the primary operator attended off-site workshops on several occasions. Furthermore, the fact that the primary operator was to be certified to the level of Montreal Lake's plant in September of 2007 implies that education and training requirements were satisfied. For these reasons, both indicators related to education and training opportunities were rated to show capacity.

Finally, it should be noted that a CRTP in place does not necessarily ensure that operators will be adequately educated or trained. INAC has always been concerned with the level of consistency and quality in training First Nations operators receive from tribal councils and other organizations. Some trainers simply do a better job and offer more support to operators than others, which was also noted by the Expert Panel (2006). For example, at one point in Saskatchewan 30% of operators in the CRTP had only the bare minimum of knowledge necessary to operate a plant, whereas in Quebec 40% of operators did not have sufficient knowledge to operate the facilities (Edwards, 2001).

5.3 Institutional Capacity

The institutional capacity of the community of Montreal Lake to provide safe drinking water rests in the existing legislation, protocols, and plans. As discussed in Chapter 2, the absence of federal legislation and ambiguity of roles and responsibilities in guidelines for First Nations water management are well documented. Consequently, they were focal points in this research. In total, seven indicators were used to assess institutional capacity. Of the seven indicators, two pertained to federal legislation; four related to plans, policies, and guidelines which covered roles and responsibilities, water quality emergencies, and regular provision of drinking water; and one reported on source water protection. The following provides an explanation of the institutional capacity indicator ratings in Table 5.1

5.3.1 Federal Legislation

In the majority of communities across Canada the regulation of water and wastewater operations and systems is the responsibility of the provincial and territorial governments (Expert Panel, 2006; Hill et al., 2006). Standards differ among the jurisdictions, but overall the regulation of drinking water safety at the provincial and territorial level has improved in recent years (Christensen, 2006; Hill et al., 2006). In First Nations communities, the federal government has a fiduciary responsibility and direct legal authority to provide safe drinking water stemming from the *Royal Proclamation Act of 1763,* and also dictated by the Supreme Court of Canada and by section 35 of the *Constitution Act,* 1982 (Morris et al., 2007; Expert Panel, 2006; Chiefs of Ontario, 2001). At the present time, there is no federal legislation governing the provision of drinking water in First Nations communities. Instead of laws and regulations, the federal government uses policies, administrative guidelines, and funding arrangements to ensure access to safe drinking water. Previous research noted the lack of legislation and branded the current federal guidelines as vague, poorly coordinated, incomplete, and not implemented consistently (Graham, 2002; O'Connor, 2002; Chiefs of Ontario, 2001). Furthermore, the only consequence that funding arrangements impose for failing to carry out tests or follow guidelines is withholding funds, a penalty which would only exacerbate drinking water safety issues (Davids, 2006). However, it was not until the *2005 Report of the Commissioner of the Environment and Sustainable Development to the House of Commons* was released by the Office of the Auditor General (2005) that the lack of a regulatory framework for First Nations drinking water safety began to be seriously considered by the federal government (Christensen, 2006). The report's main conclusion was that residents of First Nations communities do not benefit from a level of drinking water protection comparable to that of people who live off reserves due in part to the absence of laws and regulations governing the provision of drinking water (Office of the Auditor General, 2005).

In response, as part of an immediate action plan announced in March 2006 to address the longstanding issue of unsafe drinking water in many First Nation communities located on reserves, the federal government created the Expert Panel on Safe Drinking Water for First Nations (hereafter referred to as the Expert Panel 2006) to consider the options for a regulatory framework as a means of ensuring water quality. In their final report, the Expert Panel (2006) offered three possible routes to the development of a comprehensive and regulatory framework: (1) Parliament could enact a new statute setting out uniform federal standards and requirements, (2) Parliament could enact a new statute referencing existing provincial regulatory regimes, or (3) First Nations could develop a basis of customary law that would then be enshrined in a new federal statute. The final decision as to the selection of the preferred option now rests with the Minister of Indian Affairs and Northern Development who will work with First Nations and other partners in the water sector to determine how to move forward (Expert Panel, 2006). Until binding laws are in place, however, there is no legal incentive for the federal government to pursue its policy of ensuring that people on reserves attain a comparable level of drinking water safety to that of people who live off reserves in communities of similar size and location (Christensen, 2006).

The current lack of a regulatory framework governing the provision of drinking water in First Nations communities was considered a deficiency to the institutional capacity of Montreal Lake. Effective legislation is a major driver in establishing accountability, preventing complacency, permitting traditional enforcement and enabling regulators to perform their duties, and ensuring that water treatment and distribution systems are operated and maintained in a fashion that adequately protects the public (CCPE, 2005; Graham, 2002). The presence of legal mechanisms in the response to unsafe conditions can be critical in view of the high risks of unsafe drinking water (O'Connor, 2002).

There is no denying that Montreal Lake currently lacks a regulatory regime for drinking water, and if one were to be put in place the likelihood of maintaining a safe level of drinking water protection over time would increase. Consequently both indicators pertaining to legislation were given the lowest possible rating in Table 2.1 to reflect the regulatory gap and demonstrate the deficiency in institutional capacity. The Office of the Auditor General (2005) and Christensen (2006) consider the absence of legislation as a major deficiency in both institutional and the overall capacity of all First Nations communities to provide safe drinking water. However, this thesis is more in line with the Expert Panel (2006) who concludes that regulation may be the least important aspect of water system safety. In other words, legislation pertaining to the provision of drinking water is necessary, but insufficient in ensuring safety.

The Expert Panel (2006) determined that increased financial capacity and human resources capacity are the most critical components towards improving the overall safety of drinking water in First Nations communities. Safe systems are built on the technical capacity of facilities and operations, dedication of operators, support from leaders and experts, and community-wide understanding, whereas regulation is just one component of a comprehensive approach to water quality and can not ensure safe drinking water on its own (Expert Panel, 2006). Furthermore, without the investment needed to build capacity, regulation may even put drinking water safety at risk by diverting badly needed resources into legislative frameworks and compliance costs (Expert Panel, 2006). In the case of Montreal Lake, this research perhaps goes even one step further by cautiously suggesting that the community still exhibits institutional capacity despite not having legislation in place. This is mainly due to the extent of guidelines and plans for the provision of drinking water that exist both at the federal and the local level which will be discussed in the next section. In addition, the current consequence imposed by Health Canada's funding arrangements to withhold funds when tests are not carried out, acts as a driver for the community's water treatment plant operators in their monitoring activities. Finally, similar to what the Expert Panel (2006) reported during their public hearings with First Nations communities, tribal councils, and federal departments, did not view regulation as a major issue in drinking water safety by participants in the Montreal Lake research. In fact, not once was the absence of legislation identified as a source of concern or even an area in need of attention by workshop or interview participants. This finding is consistent with that of the Expert Panel (2006). Considering the high profile that was placed on First Nations drinking water regulation shortly before the time fieldwork took place including a public hearing of the Expert Panel (2006) in Saskatoon on July 26-27, 2006, a mention of the regulatory gap could have been expected. Nevertheless, the absence of regulation reduces institutional capacity and it is significant to note that First Nations communities in Canada are one of the few groups of citizens in any developed country not protected by safe water legislation (Graham, 2002).

5.3.2 Policies, Guidelines and Plans

The absence of a regulatory regime in Montreal Lake signifies that protocols, policies, and guidelines must fill the void and provide direction in the provision of drinking water. Although not legally binding, it was determined through this research that these documents present sufficient guidance for water system personnel to follow in order to deliver safe water to the community's residents. The institutional environment in Montreal Lake includes policies from federal agencies, the tribal council, the community, and to a lesser extent Saskatchewan Environment.

At the federal level, the most relevant document is the *Protocol for Safe Drinking Water in First Nations Communities* which was developed by First Nations representatives, INAC, Public Works and Government Services Canada, Health Canada, and Environment Canada, as part of the Standards Development and Implementation component of the First Nations Water Management Strategy (FNWMS). INAC published and implemented the *Protocol for Safe Drinking Water in First Nations Communities* in March of 2006 to supplement the federal government's plan of action to address the longstanding issue of unsafe drinking water in many First Nation communities. INAC (2006a) establishes clear standards for the design, construction, operation, maintenance and monitoring of treatment facilities, and sets out clear roles and responsibilities for all those accountable in the provision of drinking water. The comprehensive protocol covers all elements specific to drinking water management in First Nation communities and also provides guidance in areas such as quality assurance, operator certification requirements, emergency response plan requirements, public reporting, and developing a source water protection plan. In some cases, perhaps to keep the protocol at a manageable length, INAC (2006a) refers to other documentation as the baseline for standards. For example, the design standards in the protocol are stipulated in INAC (2006b). In addition, INAC (2006a) clearly acknowledges that it is a working document and will be updated on their website as required to reflect changes in policy or regulation. In particular, guidelines pertaining to the development of a source water protection plan which are discussed in detail in the following section and the requirements for trucked water systems are currently under development. It is also noted that several related documents such as a commissioning guide for any new or upgraded water systems being placed into service and the Asset Condition Report System Manual will be made available at the general INAC website. INAC (2006a) also contains a guide for annual inspections of First Nations Drinking Water Systems that are carried about by INAC employees. This guide was followed during the 2007 inspection of the Montreal Lake Water Treatment Plant. The protocol's operation, monitoring, maintenance, and reporting standards were used as the basis for the inspection which demonstrates the current application of INAC (2006a) in the provision of drinking water to the community's residents.

INAC (2006a) briefly touches upon the roles and responsibilities of the agencies involved in First Nations water management outlined in INAC (2004). It is reiterated that the provision of water services to First Nations communities is a shared responsibility between First Nations, INAC, and Health Canada, but that the design, construction, maintenance, and operation of water systems must now be in accordance with the *Protocol for Safe Drinking Water in First Nations Communities* instead of the program and financial terms and conditions in their funding arrangements. INAC (2006a) also provides a flowchart describing the multi-faceted partner roles and relationships between First Nations and the federal government as well as other levels of government and groups in drinking water managements (see Figure 5.1). The number of different agencies with responsibilities presented in this flowchart illustrates the complex policy and governance environment indicated by previous research (Expert Panel, 2006; NAHO, 2004).

Finally, INAC (2006a) specifies that drinking water must meet the water quality criteria identified in the latest edition of Health Canada's *Guidelines for Canadian Drinking Water Quality* (GCDWQ). The GCDWQ are periodically updated on Health Canada's website and set out the basic parameters that every water system should strive to achieve. Health Canada (2005) provides guidance to federal civil servants or other responsible authorities whose jobs relate, either directly or indirectly, to ensuring the safety of drinking water by meeting the guidelines on federal lands including First Nations communities. However, as Health Canada has transferred monitoring activities to the PAGC in the case of Montreal Lake, Health Canada (2005) has very little practical

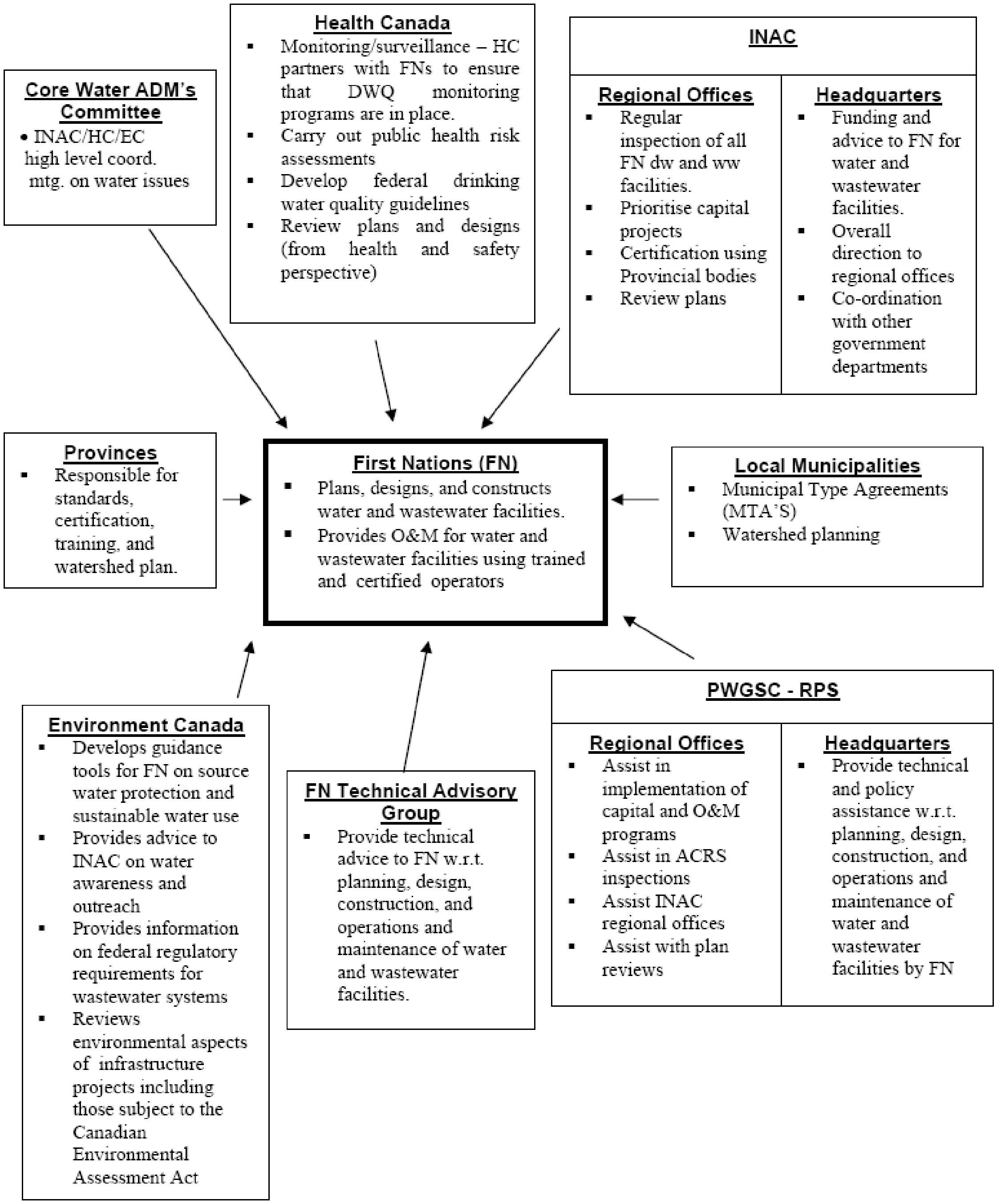

Figure 5.1 Roles and Relationships in Water Management

Source: Indian and Northern Affairs Canada. 2006a. *Protocol for Safe Drinking Water in First Nations Communities*. Gatineau, Quebec: Indian and Northern Affairs Canada.

application in the community with the exception that it may serve as reference material for members of the PAGC. Provincial policies also come into play in the community of Montreal Lake but pertain solely to the wastewater system. Montreal Lake's sewage lagoon was built according to the specifications outlined in Saskatchewan Environment (2002). In particular, the lagoon was built at a distance of 300m from the community and the storage cell was required to have sufficient volume for 180 days storage.

At the local level the PAGC developed the *Drinking Water Safety Program: Monitoring and Response Protocol* in 2005. This protocol applies to the tribal council's 12 bands and provides guidance and direction on routine monitoring and the response to drinking water safety problems. In terms of monitoring, the protocol provides detailed information on the method of analysis, testing locations and frequency, and reporting of three categories of sampling and analysis: bacteriological, chlorine residual, and chemical/physical. The procedures for responding to unsafe water conditions are described in the protocol as a four-level process of increasing severity: (1) adjusting the chlorine residual, (2) precautionary water line flushing (3) issuing a Precautionary Drinking Water Advisory (PDWA), and (4) issuing an Emergency Boil Water Order (EBWO). The protocol explains the circumstances that would require a PDWA (inadequate chlorine residuals, equipment malfunctions, unacceptable turbidity or particle count) and those where an EBWO (unacceptable bacteriological quality, significant deterioration of source water quality, epidemiological evidence that drinking water may be responsible for an outbreak) would be necessary to protect the health of residents. In addition, there are also sample notification letters and notices that any of the tribal council's bands could modify when issuing or rescinding a PDWA or EBWO. The Expert Panel (2006) noted that there currently lacks a clear chain of responsibility and legal authority to issue either a PDWA or an EBWO, but in practice First Nations and federal bodies may both be involved in these decisions. This is somewhat the case in Montreal Lake, as anybody involved in drinking water management, public heath, or even a community member can issue a boil water advisory if s/he feel the water is in jeopardy. However, in terms of the response to and removal of drinking water advisories, there seems to be clear chain of responsibility within the community. Plant operators, band council, tribal council, and INAC are all in agreement that both the health and engineering departments from the PAGC would be required to take charge during unsafe water quality conditions.

This protocol provides a detailed description of the roles and responsibilities in the provision of safe drinking water at the band and tribal council level including the band administration, medical health officer, community drinking water safety team and team manager, water quality technician/community based water monitor, water treatment plant operators, and the environmental health officer. At present, the community of Montreal Lake has not instituted or does not have the human resources required to fill all these positions. Although the band council has been planning to establish the community drinking water safety team since the fall of 2006, the team's formation was still in progress in September 2007. There are also no water quality technicians/community based water monitors in Montreal Lake and instead their duties are performed by the water treatment plant operators. Finally, the protocol also contains the procedures for the shock-chlorination of wells and more relevant to Montreal Lake, the cleaning of cisterns and the cleaning and disinfection of water delivery trucks.

At the community level some guidelines have been developed, but Montreal Lake currently lacks a tailored comprehensive drinking water management strategy. A functional maintenance management plan has been established for the water system, and the water treatment plant operators have developed a draft of an emergency response plan which INAC would like to see go into the final stages. It can be expected that once the community drinking water safety team is established additional community-specific guidelines will be developed, or at the very least the PAGC's *Drinking Water Safety Program: Monitoring and Response Protocol* will be modified to account for the Montreal Lake context.

The presence and extent of protocols, guidelines, and plans at the federal and local level were interpreted as a demonstration of capacity. As a result all four institutional capacity indicators pertaining to these guiding documents were given a positive rating. The FNWMS prompted the development of the comprehensive *Protocol for Safe Drinking Water in First Nations Communities* which provides Montreal Lake with guidance and outlines the standards it must strive to achieve. The protocol is already in effect within the community as evidenced by its use in the 2007 water treatment plant inspection. The roles and responsibilities in drinking water management described in federal publications such as INAC (2006a) and INAC (2004) are somewhat vague when it comes to the actions of personnel at the First Nations level. Fortunately, Montreal Lake is a member of the PAGC which developed the *Drinking Water Safety Program: Monitoring and Response Protocol*. This document clarifies and details the roles and responsibilities of Montreal Lake personnel and the regular activities that must be performed. In addition, the protocol provides guidance on the procedures required to respond to any water quality emergencies. The institutional environment created by these two protocols and other supporting documents from federal, provincial, and band agencies ensures that guidance is provided on all actions pertaining to the provision of safe drinking water in Montreal Lake.

5.3.3 Source Water Protection Plan

The first component in the multi-barrier, or source-to-tap, approach to drinking water safety is source water protection. Source water protection involves managing the release of contaminants from human activities including sewage, industrial effluents, farming, forestry and urban development into water bodies that are used to provide drinking water (Timmer et al., 2007; Expert Panel, 2006). It has been recognized as a priority in jurisdictions around the world as it can prevent some contaminants from entering the water supply, is less expensive than treating contaminated supplies, and is key to maintaining the quality of a drinking water source over time (Timmer et al., 2007; CCME, 2004; O'Connor, 2002). The community of Montreal Lake is fortunate in the sense that their drinking water is drawn from a nearly pristine surface water source. The lake's net area is 454 km^2 and is completely undeveloped around its entire shores (Natural Resources Canada, 2004). There is some forestry activity within the watershed and recreational use of the lake, but overall there are very few contaminants entering Montreal Lake's drinking water supply. The biggest threat for contamination as viewed by community residents and some interview participants is effluent from the sewage lagoon being discharged into the lake without being sufficiently treated. The effluent is released on the same shore as the drinking water intake pipe approximately 1100m away. However, according to INAC engineers and supported by Environment Canada the lagoon was built following the guidelines set out in Saskatchewan Environment (2002), and the effluent receiver, consisting of a muskeg area, acts as third level tertiary treatment before the effluent reaches the creek that eventually runs into the lake. Nevertheless, residents may be justified in their concerns as it is well documented that pathogens from human and animal fecal waste pose the greatest risk to drinking water safety (Hrudey and Hrudey, 2004). Therefore, a potential source of contamination will never be far from Montreal Lake's drinking water supply especially when the proximity of the effluent release and water intake pipe is considered.

A source water protection plan is essentially a strategy to prevent, minimise, or control potential sources of contaminants in or near a community's raw water source (INAC, 2006a; CCME, 2004). O'Connor (2002) stressed the importance of developing source water protection plans and recommended their implementation as a key component of ensuring drinking water safety. However, much like most communities across Canada, Montreal Lake currently does not have a source water protection plan in place (Hill et al., 2006). Source water protection planning is still a relatively new concept in Canada but has received substantial attention in recent years, especially since the

Walkerton and North Battleford disasters (Morris et al., 2007; Hill et al., 2006). In particular, the provincial governments of Ontario, Nova Scotia, and Saskatchewan have made source water protection a focus (Morris et al., 2007). Despite not having a source water protection plan at the moment, there are resources available to assist Montreal Lake in the development of their own plan. INAC (2006a) currently supplies provisional guidance, but this will be superseded once Environment Canada completes a protocol designed to aid operating authorities of water systems in First Nations communities develop source water protection plans (Environment Canada, 2006b). Environment Canada's source water protection guide is part of their contribution to the FNWMS and is expected to be complete in 2008 (Environment Canada, 2006b).

The absence of a source water protection plan was considered to be a deficiency in the institutional capacity of Montreal Lake. Therefore, the capacity indicator pertaining to a source water protection plan was given a negative rating. Considering the high quality of Montreal Lake's source water and undeveloped watershed, protection may not yet be on the radar of those in charge of providing drinking water. However, the development of a source water protection plan is an important first step in the maintenance of high quality source water into the future. Furthermore, a source water protection plan may also help the community address some current minor concerns with the drinking water intake pipe. The intake pipe began to pick up sediment and garbage in the fall of 2006 which some participants attributed to the conversion of a forested area to open fields around the intake structure (Figure 5.2). These fields are often used for community events and there is often garbage left behind which eventually ends up in the water intake pipe and must be removed by water treatment plant operators. Figure 5.2 illustrates the debris and the lack of a protected area surrounding the intake structure. The implementation of a source water protection plan may be successful in eliminating garbage from finding its way into the drinking water system, or at the very least may raise awareness of the impacts residents have on drinking water quality through their activities on land.

Figure 5.2 Montreal Lake Water Intake Building and Surroundings (August, 2007)

5.4 Social/Political Capacity

The social/political capacity of Montreal Lake refers to leadership, partnerships, and public involvement in the provision of drinking water. Figure 5.1 illustrates the magnitude and complexity of partner roles and relationships in First Nations water management. As noted by NAHO (2004), the presence of so many agencies creates an environment of jurisdictional issues. Effective linkages between groups must therefore exist not only to permit a coordinated approach, but also to ensure that residents benefit from a high level of drinking water safety. Accordingly, four of the seven social/capacity indicators focused on the quality of horizontal and vertical linkages. Of the remaining three, one indicator examined leadership while two indicators pertained to public involvement. Some of the elements of social/political capacity are also examined as part of institutional capacity. For example, institutional capacity indicators concerning roles and responsibilities partially consider leadership and linkages. However, an important distinction can be made between the two dimensions. The institutional environment surrounding leadership and linkages was regarded as the guidelines on how different agencies should interact. In contrast, social/political capacity examines the actual type and frequency of communication between groups. The rationale behind the social/capacity indicators ratings in Table 5.1 are explained below.

5.4.1 Leadership

Leadership is widely considered a critical element of capacity (de Loë et al., 2002). In this study, leadership refers to the direction and delineation of operation and maintenance activities. A primary consideration of leadership is its clarity (Timmer et al., 2007). The Expert Panel (2006) noted that with many different agencies involved in the First Nations setting, it would not be surprising that some would have different, even diverging interests. As described in earlier sections, the provision of drinking water to

Montreal Lake's residents is a joint effort between the water treatment plant operators, band council, PAGC utilities trainers and environmental health officer, and INAC employees. With a multitude of parties involved, it is essential for an agreement to exist on who is ultimately in charge of management activities within Montreal Lake.

Leadership in drinking water management also involves financial and planning components. However, guidance in these areas is well-established and transparent in Montreal Lake. Funding is provided entirely from the federal government and was discussed in detail in Section 5.1. Therefore, clear financial arrangements exist in Montreal Lake and do not need to be discussed further here. INAC also provides leadership in the form of vision and direction in the overall design of the community's drinking water system (McGuire et al., 1994). For example, the planning and construction of the community's new subdivision and water infrastructure are entirely directed by INAC. As little ambiguity surrounds the acquisition of funds and water system design in Montreal Lake, the examination of leadership focused on often poorly defined management activities (Office of the Auditor General, 2005).

Interview participants agreed that in Montreal Lake, a combination of the community's water system personnel and PAGC employees provide leadership in the duties associated with the provision of safe drinking water. For the most part, the water treatment plant operators and band council are able to operate and maintain the system adequately and efficiently. Periodically though, the operators look to the PAGC for advice on issues they are unsure of. In turn, if either the PAGC environmental health officer or utilities trainers notice something amiss during their visits to Montreal Lake, they will consult with Health Canada or INAC. Usually the objective of this consultation is to request more money. INAC only visits the community once or twice a year for inspections, while Health Canada's responsibilities have been fully transferred to the PAGC.

Because participants held the same opinion, leadership in drinking water management was considered to be lucid in Montreal Lake. Clear responsibilities exist in the community where the operators and band council are in charge of all day-to-day operation and maintenance. At the same time, a transparent chain of support is also in place. The community's first option, if an issue arises, is to consult with the PAGC who may subsequently choose to ask for assistance from the federal government. The presence of clear leadership was viewed as an indication of social/political capacity. Its indicator was rated accordingly.

Finally, it should be noted that the ability of leaders to forge external and internal linkages is often measured in capacity studies (de Loë et al., 2002; USEPA, 1998). However, in the case of Montreal Lake, most of these partnerships are the result of the federal government's fiduciary responsibility to First Nations communities. In addition, four social/political capacity indicators are dedicated solely to the assessment of linkages. For these reasons, linkages were not deemed to be a component of leadership and are discussed in the following section.

5.4.2 Linkages

In drinking water management, linkages refer to the partnerships a water system has with external organizations. Linkages are described as being either horizontal or vertical. Horizontal linkages involve associations with other organizations at the local level whereas vertical linkages represent connections with higher levels of authority (de Loë et al., 2002; McGuire et al., 1994). There are many benefits to forming linkages at both levels including access to technical and financial assistance, sharing of data, equipment, and staff, and help in overcoming jurisdictional barriers (de Loë and Kreutzwiser, 2005; de Loë et al., 2002; USEPA, 1998; McGuire et al., 1994). Not surprisingly, the presence of well-developed linkages is considered a critical element of capacity (de Loë et al., 2002; McGuire et al., 1994).

The importance of linkages resonates acutely in the context of First Nations water systems. As described in earlier sections, most First Nations communities are reliant upon external sources of support in order to provide their residents with safe drinking water. Therefore, vertical linkages must exist between communities and federal agencies, and in some cases tribal councils where transfer programs have been established. The current system of First Nations dinking water management is based on vertical linkages, or in other words the federal government's fiduciary responsibility to First Nations. Without the technical and financial assistance provided mainly by INAC and Health Canada, many more communities would be incapable of delivering potable water.

Although vertical linkages are present in First Nations water systems, the Office of the Auditor General (2005) revealed that many are inadequate. In particular, there seems to be lack of communication and sharing of information between First Nations and INAC (Office of the Auditor General, 2005). Sporadic communication can be a factor in the neglect of water issues for a considerable amount of time (Dziegielewski and Bik, 2004). For example, information on sampling results, treatment performance, and maintenance activities must be shared on regular basis to ensure that technical experts are aware of water quality and able to make necessary adjustments. Furthermore, matters such as the status of water system infrastructure must also be disclosed so that required maintenance or repairs can be performed. Therefore, even though linkages are present in First Nations communities, they might not be sufficient to ensure that distributed water is as safe as possible.

Taking the findings of the Office of the Auditor General (2005) into consideration, the contribution of linkages to social/political capacity should be assessed based on their vitality. In this study, an active linkage is defined as a partnership where pertinent water system information is exchanged between organizations on a regular basis. More specifically, an active linkage is characterized by the communication of deficiencies and progress in a manner that enables the water system to operate at the safest possible level. In Montreal Lake, four linkages are associated with the provision of drinking water. Three of these partnerships are vertical as they exist between different levels of authority: (1) Montreal Lake water system personnel and the PAGC, (2) Montreal Lake water system personnel and INAC, and (3) the PAGC and INAC. The other linkage, between Montreal Lake water system personnel and the community's band and Elders councils, is horizontal.

The partnership between Montreal Lake's water system personnel and both departments of the PAGC is active. Participants agreed that most of the time there is good communication between them. It was evident during fieldwork that the PAGC environmental health officer makes regular visits to the community to meet with water system personnel even when the system is operating safely. Operators are diligent with their weekly monitoring duties and send all results to the PAGC for quality assurance. The environmental health officer also works with operators on certain tasks. For example, during June 2007 the two groups set up a surface water sampling program to determine if effluent was being released without proper treatment into Montreal Lake. The PAGC utilities trainers and the community's water system personnel also have a strong relationship. Utilities trainers provide on-site support to operators when requested. Together, they come up with solutions on how to improve water treatment processes. This was demonstrated in late August 2007 when the two parties decided to eliminate the use of polymer coagulant due to the high turbidity levels. The active linkage between both departments of the PAGC and Montreal Lake water system personnel was viewed as a presence of social/political capacity. Therefore, its capacity indicator was positively rated.

During fieldwork, the practice of INAC employees was to visit the community of Montreal Lake once or twice a year to inspect the water system. Once complete, copies of the inspection report were then submitted to the Band Council, water treatment plant operators, the PAGC environmental health officer, and the PAGC utilities trainers. The report outlines any water system deficiencies and suggests the actions that should be taken to address the situation. Essentially, this process is in place to protect INAC's investment in the community's water system infrastructure. More importantly though, the inspections and proposed remedial actions are a method of ensuring residents receive safe drinking water. On the community side, Montreal Lake's water system personnel are not in regular contact with INAC. They are provided with support from the PAGC for both monitoring and system operation and are therefore have no need to turn to INAC employees. Inspections, or communication, on an annual or semi-annual basis is considered a weak linkage in this study. Treatment performance and water quality can degrade rapidly over time. If any water system issues arise, there is the possibility that they might not be addressed or discovered for a considerable amount of time if the facility is only inspected once or twice a year. Therefore, a weak linkage at this level may enable a safety threat to persist for extended periods.

The potential health risk posed by the weak linkage between Montreal Lake and INAC was illustrated during fieldwork. However, it must be noted that this may have been partially outside of either group's control. Montreal Lake's 2006 INAC inspection report was never completed because the inspector left the agency shortly after. INAC did not examine the facility again until August 2007, two years after the previous inspection. The 2007 inspection report revealed several water system deficiencies including incidences of high turbidity levels, low chlorine residual levels, and missing data from the daily plant records spanning April 1, 2006 - March 31, 2007. Some of the deficiencies were present for more than half of the fiscal year. This means that residents of Montreal Lake were exposed drinking water safety threats for a considerable amount of time. Perhaps if the 2006 inspection report had been completed, some of the deficiencies may have been flagged and remediation plans would have been put in place. However, the fact that the 2007 inspection report only covered one year of data illustrates the reality that health risks may be neglected for extended periods if water systems are not regularly inspected. Clearly, a partnership where communication only takes place once or twice a year is inadequate.

INAC was aware of the shortcomings of their linkage to Montreal Lake and other First Nations communities during fieldwork. The agency was in the process of creating an interdepartmental team focused solely on inspecting water systems and working with First Nations water system personnel on a more regular basis. Montreal Lake's 2007 inspection report was a direct result of the initiative. Since the establishment of the interdepartmental team, communication has improved significantly between INAC and Montreal Lake water system personnel. Because of this improvement, the capacity indicator pertaining to their relationship was rated as partially meeting the standard. The indicator rating still reflects an absence of social/political capacity due to the potential health risks that existed as a result of the weak linkage throughout fieldwork.

The linkage between the PAGC and INAC was considered to be relevant for Montreal Lake's water system because these agencies represent the main sources of support available to the community's water system personnel. INAC funds the PAGC to run the CRTP. The PAGC environmental health officer also performs quality assurance for the community's drinking water monitoring program. Therefore it was assumed that both groups would regularly communicate to inform each other of concerns with, or progress being made in the operation of the water system. However, participants expressed that communication was not adequate between the PAGC and INAC. Participants also suggested that more interaction would be a positive step forward. For example, the PAGC was not notified for several months that Montreal Lake's 2006 INAC inspection report was not completed. This failure in communication not only prevents a timely response to any potential water system needs, but also indicates a disjointed effort in providing safe drinking water to Montreal Lake residents (Dziegielewski and Bik, 2004).

The 2007 inspection report shows signs that INAC is attempting to increase its involvement with the PAGC. In particular, INAC explicitly suggests that PAGC representatives participate in the development of a remediation plan for the facility's turbidity problem. Therefore, similar to its recent conduct with Montreal Lake water system personnel, INAC is striving to enhance its partnership with the PAGC. Nevertheless, because of a lack of communication during fieldwork, the indicator pertaining to this linkage was rated as partially meeting the capacity standard; thereby indicating an absence of social/political capacity. Finally, the partnership between the PAGC and Health Canada was positively described by a participant. However, as Health

Canada has a very limited role in Montreal Lake, this linkage was not considered in this study.

The lone horizontal linkage in Montreal Lake exists between the water system personnel, and the band and Elders councils. Horizontal linkages are typically among similar organizations at the local level; for example, the band councils of neighbouring First Nations communities (Pirie et al., 2004; de Loë et al., 2002; McGuire et al., 1994). External partnerships allow organizations to overcome the limitations of their administrative boundaries and increase their available resources (de Loë et al., 2002). The linkage between Montreal Lake's water system personnel and its councils is entirely internal. However, it was considered a horizontal linkage in this study because the relationship between these groups results in increased drinking water safety. Furthermore, First Nations councils and water system personnel do not always share a partnership where drinking water issues are given a high priority (Expert Panel 2006).

The most visible aspect of Montreal Lake's horizontal linkage is the fact that the water system supervisor is also the band councilor in charge of infrastructure. First Nations operators are often supervised by their band council, but it is important to acknowledge that a direct relationship is also in place in Montreal Lake (INAC, 2006a). The band councilor has a strong working relationship with the operators, and has a great understanding of the community's water infrastructure. More importantly, the councilor is respected by other members of the band council and in a position to communicate Montreal Lake's water system needs directly to them. The other component of the community's horizontal linkage is the relationship between water system personnel and Montreal Lake's Elders council. The Elders council is very vocal and well respected when it comes to any issues within the community. Responses from both workshop and interview participants indicated that the Elders council is particularly concerned with the impact of the sewage lagoon on water quality, which will be examined in greater detail in the following section. The Elders council discusses drinking water safety at almost every Assembly meeting in Montreal Lake which pushes the operators to adequately perform their activities. The concern from the Elders also promotes the public disclosure of water quality information from operators. For example, the operators have been asked to reveal the specifications of the sewage lagoon and raw water quality data following the discharge of effluent.

In Montreal Lake, the close relationship between the operators and councils creates an environment where drinking water safety is transparent and given a high priority. Community leaders have taken an interest in water quality and the progress of the water treatment plant operators. The operators also have direct access to decision makers as their supervisor is also a Band councilor. For these reasons, the indicator pertaining to the community's horizontal linkage was rated to reflect social/political capacity.

5.4.3 Public Involvement

INAC (2004) and the Expert Panel (2006) both noted the critical importance of establishing and maintaining community involvement in First Nations drinking water management. Public awareness and participation strongly influence the operation of small water systems and overall social/political capacity (de Loë and Kreutzwiser, 2005; CCME 2004; Dziegielewski and Bik, 2004; Flora, 2004). Essentially, the actions of residents within a watershed are the first step in the protection of drinking water quality. If the public understands their impact on water quality, they are able to participate in or initiate safeguarding activities (de Loë and Kreutzwiser, 2005; CCME, 2004). As more members of the public become involved, the success of protection initiatives generally increases resulting in improved drinking water management (CCME, 2004; de Loë et al., 2002). Furthermore, when the public participate in decision making, they ensure that their interests are taken into account (CCME, 2004; Litke and Day, 1998).

In order for residents to become involved in drinking water management activities, they must first be conscious of the importance of water quality issues. The level of community awareness is partly a result of the ability of the individuals directly involved in drinking water management to foster an understanding of concerns among residents (de Loë et al., 2002). Increasing public awareness can be accomplished by administering information and education sessions, providing education materials, making monitoring results available, and issuing regular reports about the drinking water system (CCME, 2004; de Loë et al., 2002). Very little public outreach takes place in Montreal Lake. In the past, the PAGC conducted some environmental education sessions in schools. However, interview participants revealed that this program has been discontinued. Water quality data are made available by operators to community leaders and residents upon request, but there is no regular sharing or dispersal of drinking water information within the community. The lack of community outreach in Montreal Lake may be explained by a lack of resources to develop a public relations strategy. Or, a public education campaign addressing drinking water safety may simply not be as pressing as other community needs. Whatever the case, increased public awareness may result in improved public health which is reason enough for Montreal Lake to educate its residents about drinking water safety (CCME, 2004). Furthermore, an interview participant identified the lack of public understanding as the only barrier towards a coordinated approach to safe drinking water. In particular, the participant felt that most residents assume that water from the tap is always safe and do not comprehend the amount of work required to make it potable.

In addition to public outreach, community interest in drinking water safety also affects the level of awareness. Interview and workshop participants suggested that concern for drinking water safety is mixed within the community. Responses indicated that most individuals in Montreal Lake do not pay much attention to drinking water. In general, residents believe their water is of better quality than that of major Saskatchewan cities such as Saskatoon and Regina, and are only troubled when service is disrupted due to broken water lines. However, there is a small minority within the community that is highly concerned with drinking safety. As mentioned in the above section, the Elders council views the proximity of the sewage lagoon to Montreal Lake as a major health threat. The lagoon is built to Saskatchewan Environment (2002) standards and provides tertiary (third level) treatment according to INAC engineers and approved by Environment Canada. However, study participants specified that many of the community's elders are concerned that effluent is released into the lake without being sufficiently treated, contaminating the drinking water supply. Figure 5.3 shows the sewage lagoon in relation to the community's water intake pipe. When discharged, effluent travels 250m through muskeg before reaching Montreal Lake. The intake pipe is

Figure 5.3 Montreal Lake Sewage Lagoon and Lake Intake
Modified from: Google Earth. 2007. Version 3.0.0739.0. [Online]. http://earth.google.com. Accessed 01-June-2007.

located 1100m away on the same lake shore. According to INAC's 2005 wastewater system inspection report, the effluent release is not considered to be directly upstream of the intake pipe due to the large size of Montreal Lake. However, certain conditions may dictate otherwise. For this reason, community elders remain concerned about the lagoon discharge.

During fieldwork, interview and workshop participants stressed that many of the community's elders were becoming increasingly vocal about their lagoon suspicions.Elders were aware that the lagoon is built to provincial standards and that past raw water quality tests revealed no contamination, but still attributed certain health issues to the lagoon's proximity. Simply put, many community Elders did not trust the quality of their drinking water out of the tap. Instead, some individuals boil their water or purchase bottled water. As a result of the growing concern among Elders and community leaders, the water treatment plant operators were asked to take raw water samples following the spring discharge of the lagoon in June 2007. The samples revealed levels of 4.2 most probable number (MPN) total coliform per 100ml and 1.0 MPN *E. coli* per 100ml. According to the *Guidelines for Recreational Water Quality*, these quantities fall below the microbiological parameters of 200 MPN *E. coli* or total coliform per 100ml (Health and Welfare Canada, 1992).

It should be stated that it is the amount of bacteria in treated water, not raw water, which is significant. The drinking water distributed to residents should contain zero bacteriological indicator organisms. The raw samples simply suggest that the source of

Montreal Lake's drinking is safe for swimming and recreational use. It could also be implied that the effluent is properly treated before being released as bacteria levels remain low after discharge. However, a thorough examination of the health threat posed by the lagoon to community residents was beyond the scope of the study. Instead, the focus was placed on whether effluent was contaminating drinking water during fieldwork. The raw water samples taken in June 2007 indicate that the lagoon currently processes and releases wastewater in a safe manner. Nevertheless, the potential for contamination remains. Human and animal wastes present the most serious threat to public health when in contact with drinking water (Expert Panel, 2006; Saskatchewan Environment, 2003a). Therefore, a large source of these contaminants in close proximity to the drinking water supply may always be considered a potential hazard (Christensen, 2006). It would not be surprising if the lagoon remained a concern among residents even after the results of raw water tests are circulated.

The above example illustrates how public awareness and involvement may improve drinking water safety. By continually voicing their concern about the lagoon, residents were successful in having additional water samples taken after the spring effluent discharge. This increased testing of source water helps protect public health by identifying in advance, potential contaminants which may make their way to the intake pipe. Unfortunately, public awareness and involvement in drinking water safety is infrequent in Montreal Lake. As described earlier, only a small proportion of community residents are concerned with drinking water issues. Furthermore, residents do not have the opportunity to become regularly involved in decisions pertaining to the management of drinking water. As mentioned earlier, community leaders are in the process of establishing a community drinking water safety team to coordinate the monitoring, preventative, and remedial activities of the water system. Once in place, this team could boost public involvement by including concerned residents. Until then, community participation will continue to be informal. The limited community awareness and involvement in drinking water management was viewed as a deficiency to Montreal Lake's social/political capacity. Nevertheless, both indicators were rated as somewhat meeting the capacity standard because of the notable influence of the community's Elders.

5.5 Technical Capacity

The technical capacity of Montreal Lake's water system is essentially its ability to produce and distribute water that meets the standards found in the *Guidelines for Canadian Drinking Water Quality* (GCDWQ). A water system must have adequate treatment and distribution infrastructure, source water, and monitoring in order to display technical competence. Chapter 3 of this study described in detail the technical components of the Montreal Lake water system. Therefore, this discussion will focus mainly on the rationale for the technical capacity indicator ratings found in Table 5.1. Of note is the fact that technical capacity is considered separately for the piped and truck haul distribution systems. This is to account for the significant difference in the infrastructure serving community residents. The majority of the technical capacity indicators do not relate to the distribution systems, and are therefore rated the same in both cases. However, three indicators bear divergent ratings which significantly influence the level of drinking water safety. In total, nine indicators were used to evaluate technical capacity: one reflects Montreal Lake's current water quality; three pertain to monitoring; two concern physical infrastructure; and the final three deal with source water.

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5.5.1 Current Quality

Drinking water quality varies considerably over time (Health Canada, 2007a; Coulibaby and Rodriguez, 2003). Therefore, the capacity indicator rating pertaining to this area represents only a snapshot of the situation in Montreal Lake. Specifically, the indicator reflects the community's drinking water quality during the fieldwork component of this study: September 2006 to August 2007. Water quality data and INAC inspection reports obtained during research permitted an examination of microbiological, physical, and chemical parameters.

Disease causing microbes (bacteria, viruses, protozoa) pose the most immediate health threat to drinking water supplies (Christensen, 2006; Expert Panel, 2006). For this reason, microbiological quality is a primary indicator of drinking water safety (Saskatchewan Environment, 2003a). In Montreal Lake, drinking water is tested five times per week for the presence of two bacterial indicator organisms, total coliforms and *E. coli*. Indicator organisms are used in the monitoring of drinking water because they are easily detected when specific disease-causing organisms are present (Hrudey and Hrudey, 2004). Their presence also suggests that either the water treatment plant is operating inadequately or contamination is taking place in the distribution system (Saskatchewan Environment, 2003a). Conversely, the absence of indicator organisms implies that drinking water is free from microbiological contamination. Montreal Lake's weekly water quality monitoring sheets reveal that the piped distribution system tested negative for total coliforms and *E. coli* during the fieldwork timeframe. However, participants and the 2005 INAC inspection report stated that cisterns from individual residences test positive for indicator organisms frequently. As a result, boil water advisories are issued for individual cisterns until they are cleaned.

In addition to bacteria, Montreal Lake's drinking water is also tested once a year for the presence of the protozoan *Cryptosporidium*. *Cryptosporidium* is more resistant to chlorine disinfection than bacteria and may still be present when indicator organisms are absent in water samples (Hrudey and Hrudey, 2004). It is considered a serious threat to human health and was responsible for the 2001 outbreak of gastroenteritis in North Battleford, SK that affected 5,800 to 7,100 people (Laing, 2002). Protozoans and viruses are very difficult to detect and require very specific sampling techniques and analysis that are not routinely done at most commercial laboratories (Hrudey and Hrudey, 2004). For these reasons, monitoring of these pathogens is only carried out on a periodic basis in most communities. Montreal Lake's most recent annual water quality sample did not detect the presence of *Cryptosporidium*.

The physical characteristics of drinking water (colour, temperature, turbidity, taste and odour) do not normally present a health risk on their own, but can indicate the presence of microbiological or chemical concerns (CCME, 2004; PWGSC, 2000a). For example, high amounts of turbidity can pose a problem for disinfection by shielding pathogens from direct contact with the disinfectant (Hrudey and Hrudey, 2004). Therefore, the risk of microbiological threats increases when drinking water contains elevated levels of particulate matter (CCME, 2004). During fieldwork, Montreal Lake's water treatment plant was experiencing a turbidity problem. Plant records show that from April 2006–March 2007, there were 193 incidences of high turbidity levels. The water treatment plant operators and a PAGC utilities trainer addressed the problem in August 2007 by cutting off the polymer coagulant. It was noted in December 2007 that turbidity levels off the filter have significantly improved, but remain high along the distribution lines. In other words, the quality of water distributed to residents remained above the targeted turbidity levels.

Although it is rare, dangerous amounts of chemicals (pesticides, metals, nutrients) can suddenly make their way into drinking water (Expert Panel, 2006). Most health effects from chemical contaminants tend to appear only after people have been exposed to high levels of the substance consistently over a period of years (CCME, 2004). Montreal Lake's water quality data reveal that of all chemical contaminants, only total trihalomethanes periodically exceed their GCDWQ maximum allowable concentration (MAC). Trihalomethanes are formed as by-products when the chlorine used to disinfect drinking water reacts with the natural organic matter present (Health Canada 2006;

Saskatchewan Environment, 2003b). Although the health effects of these by-products remain unclear on humans, a link between exposure to trihalomethanes and colorectal cancers has been suggested (Expert Panel, 2006; Health Canada, 2006; Hrudey and Hrudey, 2004). Monitoring for trihalomethanes is carried out four times a year in Montreal Lake. The quarterly results are used to obtain an annual average of trihalomethanes in the community's drinking water. Montreal Lake's annual average falls below the MAC but quarterly results are periodically above.

The final aspect of Montreal Lake's current drinking water quality that must be mentioned is chlorine residual. During disinfection, enough chlorine must be added to maintain a residual capable of killing any bacteria or viruses that may contaminate drinking water after it leaves the treatment plant (CCME, 2004). Montreal Lake's water quality data from April 1, 2006-March 31, 2007 reveal 50 incidences of low chlorine residuals in treated water from the plant, and 51 incidences of low chlorine residuals in the distribution system. On their own, low chlorine residuals do not pose a health risk. However, low chlorine residuals do suggest that contamination could occur if any pathogens are in contact with Montreal Lake's drinking water after initial treatment.

Montreal Lake's drinking water quality is very similar for the piped and truck haul distribution systems in terms of high turbidity and trihalomethanes, and low chlorine residuals. However, there exists one significant difference. Drinking water from the individual cisterns frequently tests positive for microbiological contamination whereas the piped distribution system tests negative. Because contamination from microbes represents the most immediate threat to drinking water safety, the truck haul indicator for current water quality was rated as not meeting the capacity standard. Furthermore, individual cisterns are periodically under boil water advisories, certain signs of poor water quality. The piped distribution system indicator for current water quality was rated as meeting the capacity standard. The regular incidences of high turbidity were seriously considered, but ultimately, the water piped to residents does not pose an immediate health risk.

5.5.2 Monitoring

Monitoring is inherently a practice carried out by water system personnel. The diligence of Montreal Lake's water treatment operators and the PAGC environmental health officer in their monitoring activities was touched upon in the discussion of human resources capacity, Section 5.2. Although very closely related, this study considered the types of monitoring in place to be components of technical capacity. An effective monitoring program can lead to early detection of potential water quality issues and provides an ongoing evaluation of a water system's effectiveness and reliability (Smith et al., 2006). In Montreal Lake, drinking water is expected to undergo daily, weekly, quarterly, and yearly analysis to ensure it does not pose a risk to public health. This section reports on the execution of these tests.

Daily monitoring activities in Montreal Lake are focused on the performance of the water system. The water treatment plant operators ensure that the treatment plant is operating safely by checking and recording all system metres including raw water, backwash, truck-fill, and distribution. In addition, chlorine and turbidity levels must be noted to determine whether raw water is being sufficiently treated. Interview participants and inspection reports suggested that all daily tests, with the exception of turbidity, are adequately performed and recorded. The water treatment plant records from April 1, 2006 – March 31, 2007, revealed 172 out of 365 days of missing turbidity data. As described earlier, turbidity readings are important in gauging the performance of a water treatment system (Saskatchewan Environment, 2003c). If turbidity is high, the risk of microbiological contamination increases. Therefore, it is crucial for water treatment plant operators to know and record turbidity levels on a daily basis. The missing turbidity data in Montreal Lake's water treatment plant was viewed as a deficiency to technical capacity. Because the treated water is the same for the piped and truck haul systems, the indicators concerning daily monitoring were both rated as partially meeting the capacity standard.

Weekly and quarterly monitoring were grouped together as one indicator because they are the responsibility of the water treatment plant operators, and are completed at different locations throughout the community. The weekly water tests carried out in Montreal Lake are associated with bacteriological quality and the presence of chlorine residuals. Participants, the 2005 INAC inspection report, and water quality data indicated that operators are diligent in sampling for total coliforms, *E. coli*, free available chlorine, and total chlorine residual, five times per week. To ensure that all residents are receiving safe water, operators test water from five different taps each week. However, these samples are all taken from the piped distribution system. Trucked water is monitored once every two weeks before it is delivered to individual cisterns. Once in cisterns, water is only tested for bacteria and chlorine residuals twice a year. Both the PAGC's *Monitoring and Response Protocol* and Health Canada (2004) *Procedure Manual for Safe Drinking Water in First Nations Communities South of 60°* recommend a quarterly sampling frequency for cisterns, but this practice does not take place in Montreal Lake. Nevertheless, individual cisterns may be tested more frequently if health issues arise. Quarterly monitoring has also been recommended for trihalomethanes (Health Canada, 2006). As mentioned earlier, trihalomethanes are reliably monitored four times a year in Montreal Lake to obtain an annual average. The diligent monitoring of bacteria, chlorine residuals, and trihalomethanes in the piped distribution system reflects technical capacity. Therefore, its weekly and quarterly monitoring indicator was positively rated. Conversely, the absence of the recommended quarterly monitoring of individual cisterns was viewed as a technical deficiency. Nevertheless, because water is tested regularly before it is delivered to cisterns, the truck haul system's indicator was rated as partially meeting the capacity standard.

Once a year, treated and raw water samples are collected by the PAGC environmental health officer and submitted to an accredited laboratory for analysis. Water is then tested for a range of chemical contaminants and physical characteristics. In addition, samples are analyzed for microbes such as *Cryptosporidium* that are very difficult to detect. Monitoring certain parameters on an annual rather than regular basis saves a significant amount of financial and human resources. Furthermore, many contaminants are simply not found in Montreal Lake's drinking water supply. The series of annual water quality data obtained in this study indicates that yearly samples are conducted without fail. Therefore, the indicators pertaining to annual monitoring were rated as meeting the capacity standard for both distribution systems.

5.5.3 Infrastructure

Water system infrastructure in First Nations communities has been described as either entirely absent, obsolete, inappropriate, of low quality, or in poor condition (Office of the Auditor General, 2005; INAC 2003; O'Connor, 2002). The Expert Panel (2006) suggests that the deficiencies in infrastructure are a direct result of the federal government's funding shortfalls. More specifically, the Expert Panel (2006) indicates that the funds provided to First Nations have never been sufficient to ensure that the quantity and quality of water systems were comparable to that of off-reserve communities. Deficiencies in water system infrastructure can impact the safety of drinking water. The treatment process may not perform correctly if there are faults in the water treatment plant's design or construction (Office of the Auditor General, 2005). Without proper distribution infrastructure, treated water may be contaminated after it leaves the treatment plant (Smith et al., 2006).

Montreal Lake's water treatment plant was developed from the ground up in 1993. All components were upgraded in 1997. In 2004 the capacity of the reservoir and the capacity of the treatment units were both doubled. Based on its recent construction and upgrades, the treatment plant is considered to be fairly modern. Participants also suggested that the plant is completely up to date. Water treatment is performed by two US Filter Microfloc® Trimite™ TM-100A package units (Figure 5.5.1). These units are designed to remove 75-95% of the raw water turbidity before sending the flow for multimedia (rapid sand) filtration. Raw water is also dosed with a coagulant called ClearPac Plus and a non ionic polymer to assist with turbidity removal. Filtered water is disinfected with chlorine before being placed in the two storage reservoirs.

Figure 5.4 Montreal Lake Water Treatment Units (December, 2006)

Although the treatment units and raw water dosages are both aimed at reducing turbidity, Montreal Lake's water treatment plant was experiencing a turbidity problem during the fieldwork portion of this study. As discussed in the current water quality section, there were 193 incidences of high turbidity levels in treated water between April 1, 2006-

March 31, 2007. The water treatment plant operators and a PAGC utilities trainer addressed the turbidity problem in August 2007 by removing the use of polymer. As a result, turbidity levels off the filter had improved by December 2007. However, they remain high in the distribution system which might be due to number of factors including the need to flush distribution lines or improper chemical dosages.

The most significant impact of high turbidity on drinking water safety is the potential to shield microbes from disinfection (Health Canada, 2003). Therefore, high turbidity is an indication that the water treatment process is not operating at its optimum level. Despite the elevated turbidity in Montreal Lake's drinking water, disinfection appears to be adequate as treated water from the piped distribution system characteristically tests negative for bacterial contamination. However, chlorine levels may need to be adjusted slightly as there were 50 incidences of low chlorine residuals in plant water records, and 51 incidences of low chlorine residuals in the distribution water records. It is evident that Montreal Lake's water treatment plant is capable of producing safe drinking water. However, for a period of over one year, the plant experienced a turbidity problem. During this time, the capacity of the community's physical infrastructure to produce safe drinking water was reduced. Because this period coincided with fieldwork, the indicators pertaining to the generation of safe drinking water were rated as partially meeting the capacity standard for both distribution systems. It may seem contradictory to rate a previous indicator, current water quality, as meeting capacity, while the treatment plant's ability to produce water is rated as partially meeting capacity.

However, the rating for the treatment plant was based on performance. For over a year the treatment process did not operate to its full capabilities.

Drinking water is distributed to residents of Montreal Lake via either a fully piped or a truck haul distribution system. Of the 217 homes in the community, 131 are connected to the water treatment plant while 86 have water trucked to their cisterns. During the summer of 2007, an additional 36 homes were expected to be hooked up to the piped distribution system. Although more connections may be made in the future, it is very unlikely that all homes will eventually be piped water due to the large distances separating the community core from outlying residences.

Piped systems are usually the safest means of distributing water (PWGSC, 2000a). In Montreal Lake, this is substantiated by the fact that bacterial tests from the piped distribution system routinely test negative for total coliforms and *E. coli*. It should be noted that there are several sources of contamination in piped distribution systems. For example, water may become contaminated during pipe repairs, or by leaking sewage from wastewater lines when water-line pressure fluctuates (Expert Panel, 2006). Furthermore, pipe and plumbing materials (lead) were once a source of contamination themselves (Expert Panel, 2006). Water quality data and inspection reports suggested that Montreal Lake's polyethylene piped distribution is free from contamination. Workshop and interview participants indicated that pipe repairs are not uncommon in the community. They appear to be completed in a safe manner as there are no indications of contamination. The safety of the piped distribution was considered to be a sign of technical capacity. As polyethylene piping is easily replaced and repaired in Montreal Lake, the indicator pertaining to the piped distribution system's adequacy was rated as currently meeting capacity and expected to do so in the future.

The truck haul system is used in Montreal Lake because it is a cost-effective method of delivering water to outlying residences (PWGSC, 2000a). Many of the community's homes are separated by considerable distances from the community core. As a result, piped connections to the water treatment plant are not viewed as economically viable. Instead, water is trucked to individual cisterns by one of the community's two water trucks (Figure 5.5). The source of trucked water is the same as

Figure 5.5 Montreal Lake Water Trucks Filling at Water Treatment Plant (December, 2006)

the piped system, but there exists more opportunity for contamination in the former. In a piped system water travels directly from the treatment plant to residences without exposure. In a trucked system water must be loaded, transported and unloaded. There is potential for contamination at each of these steps, particularly through improper handling or failure to periodically clean trucks, hoses, and tanks (Expert Panel, 2006; Smith et al., 2006; PWGSC, 2000a).

However, the most serious risk of contamination in the truck haul system occurs during the storage of water in cisterns. Participants and the 2005 INAC inspection report revealed that individual cisterns are prone to positive bacteria tests and are often under boil water advisories until they are repaired or cleaned. The possible reasons for bacterial contamination may be cracking of tanks, misaligned manhole riser sections allowing infiltration or depleted chlorine residual from long durations in periods of low use. Moore (1999) indicated that another source of contamination is "panning" of water from cisterns using dirty pots or other containers. Furthermore, many residents may not be aware of how to properly maintain or clean cisterns (Moore, 1999). The movement in the ground is particularly damaging to cisterns in Montreal Lake forcing the replacement of twenty units during the fall of 2006. Participants suggested that cisterns are an inadequate and unsafe method of storing water. This finding is consistent with Martin et al. (2007) who found an increase of bacterial contamination in storage tanks compared to water collection sites. In addition, Martin et al. (2007) also noted the absence of free chlorine residual in cisterns. The significant potential for contamination in the loading, transport, unloading, and storage phases of the trucked water was viewed as a serious deficiency to capacity. Therefore, the indicator relating to the adequacy of the truck haul distribution system was rated as not meeting the capacity standard.

5.5.4 Source Water

Simply put, a community's drinking water source should be safe and reliable. Source water that contains high levels of microbes and chemical compounds is not only hazardous for human consumption, but also requires a considerable amount of treatment (Davies and Mazumder, 2003). If there is not a sufficient amount of source water available, the needs of users for drinking, cooking, and personal hygiene will not be met. Finally, an understanding of potential hazards that could affect source water must also be reached to ensure they are safely managed (CCME, 2004). This section describes the adequacy of Montreal Lake as a source of drinking water.

In terms of quantity, Montreal Lake is a very reliable water source. It is one of the largest freshwater lakes in central Saskatchewan with a net area of 454 km^2 (Natural Resources Canada, 2004). As mentioned earlier, there is no development along the lake's shores. Therefore, there are no significant water use projects which could potentially impact the amount of available water. It should also be noted that research by Schindler and Donahue (2006) on the freshwater resources of the western prairie provinces points to scarcity issues in the future. However, these shortages pertain to the water resources that originate in the snow and ice fields of the Rocky Mountains, and not the freshwaters like Montreal Lake supplied mainly by local precipitation. Furthermore, SWA (2007) rates the amount of available surface water in Montreal Lake's watershed as healthy. Even considering the combined impacts of climate change and population growth, participants suggested that Montreal Lake would remain a consistent water source well into the future. The reliability of the lake as a source of drinking water for years to come reflects technical capacity. Therefore, the indicators pertaining to the quantity of source water were rated as currently meeting the capacity standard and expected to do so in the future for both distribution systems.

Even though pure source water is not attainable, extremely high quality water can be found in nature in pristine surface waters (Hrudey and Hrudey, 2004). The quality of water in Montreal Lake is as close to pristine as possible. The lake's shores are completely undeveloped and local precipitation supplies over 95 percent of the water (SWA, 2006). According to annual water quality data, very few physical and chemical parameters exceed the aesthetic objectives, and none surpass the MACs, found in the GCDWQ. Nevertheless, water quality is noted to change seasonally. There is typically higher turbidity in Montreal Lake during the spring and fall due to lake turnover. The associated rapid change in water quality can potentially affect the water treatment process as it functions best under consistent conditions (Hrudey and Hrudey, 2004). However, participants indicated that the semi-annual spikes in turbidity may be easily addressed if the water treatment plant operators are alert to the timing of lake turnover. The aluminum levels in Montreal Lake also periodically exceed their aesthetic objective. Aluminum, though, is ubiquitous in the environment and there is no consistent evidence that it causes adverse health effects in humans (Health Canada, 1998). Taken together, these source water quality issues present only minor concerns for drinking water safety. Turbidity levels may be high in the community's drinking water, but this a result of improper treatment rather than the characteristics of source water. The high quality of Montreal Lake's source water is a sign of technical capacity. For this reason, the indicators relating to source water quality for both distribution systems were rated as currently meeting the capacity standard.

Human developments in a watershed substantially increase the range and magnitude of water quality problems (Hrudey and Hrudey, 2004). The absence of industrial activity and agriculture along Montreal Lake's shores results in an environment where few manmade contaminants threaten water quality. However, there is some recreational use of the lake and forestry activity in the watershed. Although these sources were noted by participants and the 2005 INAC inspection report, they do not significantly affect the quality of the community's drinking water. As discussed earlier, the biggest potential source of contaminants is the sewage lagoon. The high concentrations of pathogens in sewage effluent pose a serious threat to public health if they come in contact with drinking water (Christensen, 2006; Hrudey and Hrudey, 2004). Based on raw water quality data from June 2007, the sewage effluent does not appear to be contaminating Montreal Lake. Raw water also met the *Guidelines for Canadian Recreational Quality* following spring discharge. Lastly, in pristine watersheds in nature, there is always the risk of microbial contamination from wildlife (Hrudey and Hrudey, 2004; USEPA, 2001). Participants indicated that they are aware of the contamination threat posed by wildlife, but feel man-made sources of contamination are more severe. The fact that water-supply contaminant sources have been identified in the Montreal Lake watershed was perceived as a presence of technical capacity. Therefore, the indicators of both the piped and truck haul were rated as meeting the capacity standard.

5.6 Summary / Into the Future

This discussion described the assessment of Montreal Lake's drinking water system using capacity indicators. Unlike many First Nations water systems, it was determined that Montreal Lake exhibits financial capacity due to available, sufficient, and stable funding. However, some concerns exist as three of the eight indicators revealed deficiencies. Specifically, Montreal Lake does not generate any revenue to cover water system costs and has no reserve funds set aside for unforeseen water system needs. Together, these deficiencies limit community control of the water system and reduce the likelihood of funding always being available when required. In terms of human resources, Montreal Lake greatly benefits from diligent primary and backup operators and nearby technical assistance. Consequentially, six of the seven indicators were rated to reflect capacity, which is in agreement with the Expert Panel (2006) who concluded that human resources capacity has clearly been established in many First Nations water systems and is growing. Despite not having a regulatory regime governing the provision of drinking water and a source water protection plan in place, it was determined that Montreal Lake still exhibits institutional capacity on account of thorough protocols that exist at the federal and local levels. However, this judgment was especially close as 4 of the 7 indicators revealed the presence of capacity while the other three noted deficiencies. Social/political capacity in Montreal Lake is an area of concern. Vertical linkages and community involvement were both viewed as inadequate, resulting in only 3 of 7 indicators meeting the capacity standard. Finally, the safety difference between the community's piped and truck haul distribution systems is significant. The piped distribution system demonstrates overall technical capacity whereas residents served by the truck haul system are at risk of drinking unsafe water due mainly to problems associated with storage of water in cisterns.

Looking towards the future, it appears that drinking water management in Montreal Lake will improve in many areas. Although Montreal Lake's reliance on the federal government for water system needs will continue, at least until the community controls its economic destiny, budgets have been approved to construct new and upgrade existing infrastructure to accommodate the community's growing population. The community's primary operator is expected to be certified in the near future, at which point an already capable human resources component will be strengthened. The outlook for Montreal Lake's institutional capacity in the future is also promising. Legislation will likely be put in place now that the Expert Panel (2006) has provided three options to the Minister of Indian Affairs and Northern Development on how to move forward, and a spotlight from drinking water safety literature continues to shine on the federal government's failure to establish a regulatory regime in First Nations communities. Montreal Lake appears poised to establish a drinking water safety team to ensure the safety of their residents from the community level. In terms of social/political capacity, a concentrated effort from INAC to improve its relationship with Montreal Lake water system personnel and the PAGC is showing significant progress. Furthermore, community residents are also beginning to exert some influence in the management of their drinking water. Lastly, the recent adjustment to the water treatment process will benefit all residents and enhance technical capacity.

6.0 Conclusion

6.1 Summary of Findings

The primary objective of this study was to gain an understanding of the capacity to manage water resources in the context of a First Nations community. This knowledge can be applied directly in Montreal Lake to improve drinking water safety. In addition, the insight provided may contribute to a better understanding of the current challenges and strengths in First Nations drinking water management. Table 6.1 provides a summary of the indicator ratings that describe the capacity of Montreal Lake to provide safe water.

Table 6.1 Capacity Indicators Summary Table

Dimension	Total Indicators	Capacity		Ratio of Capacity Present to Total Indicators
		Present	Absent	
Financial Capacity	**8**	**5**	**3**	**5/8**
Human Resources Capacity	**7**	**6**	**1**	**6/7**
Institutional Capacity	**7**	**4**	**3**	**4/7**
Social/Political Capacity	**7**	**3**	**4**	**3/7**
Technical Capacity (Piped Distribution System)	**9**	**7**	**2**	**7/9**
Technical Capacity (Truck Haul System)	**9**	**4**	**5**	**4/9**
Total (Piped Distribution System)	**38**	**25**	**13**	**25/38**
Total (Truck Haul System)	**38**	**22**	**15**	**22/38**

The Office of the Auditor General (2005) noted that residents of First Nations communities do not benefit from a level of drinking water protection comparable to those people living off-reserves. In Montreal Lake, a similar difference in drinking water safety exists between those who are served by piped and trucked water. Of the 38 total indicators, 25 showed a presence of capacity for the piped distribution system, while only 22 reflected capacity for the piped distribution system. Taken as whole, these numbers suggest that Montreal Lake's water system exhibits capacity regardless of the distribution system. However, the social/political component of capacity in Montreal Lake was determined to be inadequate with only 3 of 7 indicators meeting the capacity standard. Technical capacity is also deficient for the trucked distribution system as only 4 of the 9 indicators reflect capacity. Furthermore, the research revealed that a weak institutional environment is present in Montreal Lake, illustrated by only 4 of 7 indicators meeting the capacity standard. These deficiencies are significant as the USEPA (1998) stated that a water system must demonstrate adequacy in all dimensions to display overall capacity.

This research did not reveal any serious individual deficiencies in the management of Montreal Lake's drinking water. Instead, a number of small flaws in each aspect of the drinking water system were identified. Some of the problems are common to all First Nations communities. These include poor economic conditions to generate water system funding, the lack of a certified operator, absence of a regulator regime, management complexity, and inadequate infrastructure. The specific issues that were detected in Montreal Lake's water system include the lack of public participation in drinking water management, a turbidity problem in the water treatment plant, and a different level of drinking water safety in the community. There is also the risk of source water contamination from the sewage lagoon. However, the threat from the lagoon is only a potential water quality issue at this point.

Although research examining the safety of drinking water systems in First Nations communities tends to focus on deficiencies, it is important to also recognize strengths. In Montreal Lake, residents who are piped water benefit from a high level of protection. Source water is as pristine as possible and abundant. The community's water treatment plant uses modern technology and is well funded. The water treatment plant operators are diligent in the majority of their activities and have excellent access to outside support. Although no laws and regulations or source water protection plan are in place, federal and community protocols provide guidance. Most importantly, the quality of water delivered coming out of taps meets safe drinking water standards. Residents who are trucked water also benefit from these water system strengths to a certain extent. However, the problems associated with storing water in cisterns continually places residents risk of drinking contaminated water.

At the beginning of this research, I assumed that there were no issues in the management of drinking water in Montreal Lake. There was no history of community-wide drinking water advisories or concerns of drinking water safety among residents. The results of this study indicate that there is no single serious threat to the safety of drinking water in Montreal Lake, but a number of small financial, human resources, institutional, social/political, and technical deficiencies. It appears that many of these flaws are beginning to be addressed at both the federal and community level. This research confirms the notions that capacity is a multi-dimensional concept and that it is growing, but still in need of improvement, in First Nations water systems (Expert Panel, 2006; de Loë and Lukovich, 2004).

6.2 Implications and Recommendations

The main implication of this study is that social/political deficiencies are present in Montreal Lake's drinking water system. This key finding is consistent with the position taken by the Expert Panel (2006) that management complexity in First Nations drinking water management impedes the delivery of safe drinking water. This research determined that failures in communication and low public involvement are the main factors in poor social/political capacity. Management complexity exists in Montreal Lake like all other First Nations communities, however it could also easily be eliminated. Greater communication between INAC, the PAGC, and Montreal Lake water system personnel would result in increased water safety. There are signs that it is improving, but the policy that was in place during fieldwork of inspecting water systems once or twice a year is not sufficient to ensure that residents are delivered safe water. This lesson may also be applicable to other First Nations communities in terms of their capacity to provide safe drinking water.

All things considered, the weak linkages in Montreal Lake can be attributed to substandard involvement from INAC. As in all First Nations communities across Canada, INAC also has a fiduciary responsibility and clear mandate to ensure safe drinking water is provided to residents of Montreal Lake. Furthermore, INAC is ultimately accountable for safe drinking water as the owner of the community's water system (Shanaghan and Bielanski, 2003). Although the major activities in drinking water provision are considered to be designing, constructing, financing, and operating and maintaining water systems, this thesis revealed the importance of all agencies working together to accomplish these objectives. Therefore, strong partnerships are necessary and must stem from the lead agency. There were signs at the end of the study that communication among INAC, the PAGC, and the Montreal Lake water system personnel was vastly improving. Furthermore, the improved linkages appeared to be the result of outreach from INAC employees.

For appropriate reasons, the proximity of the lagoon to Montreal Lake will remain a concern among residents well into the future. The monitoring results following spring discharge in June 2007 suggested that source water is safe. However, the potential for contamination is ever-present. It is likely that residents will become concerned with lagoon safety in the near future, and the research revealed that they are not satisfied with sporadic testing of source water quality. Testing source water on a more regular basis would respond to community concerns and act as an early warning to any potential water quality issues.

The different level of safety between the piped and truck haul distribution systems should not be ignored. Although the costs of connecting all outlying homes to the piped distribution system would be astronomical, it would ensure that all Montreal Lake residents are protected to a high level of drinking water safety. Another option would be to develop a cistern maintenance program among water treatment plant operators and residents. This program should include an educational component whereby residents are informed on proper maintenance, and involve increased bacteriological monitoring of all cisterns by the water treatment plant operators. The recurring poor water quality in cisterns warrants more attention in Montreal Lake. The significant difference in drinking water safety within Montreal Lake is another lesson for other First Nations communities that may be worth exploring.

For the above reasons, this study recommends:

- An increase in the reporting and disclosure of water system information among the agencies involved in the provision of safe drinking water

- That the recent trend of increased communication continues and that INAC fosters even closer relationships with the PAGC and Montreal Lake water system personnel. This could be accomplished through an additional water system inspection each year, or the introduction of quarterly meetings involving all parties.

- A more frequent source water monitoring program be put in place. At the very least, annual raw water samples should be taken after the lagoon's spring discharge. Although lake freeze-up would undoubtedly create some complications, intermittent monitoring could also be conducted throughout the year.

- An improved cistern maintenance program be developed if a community-wide piped distribution system remains economically unfeasible.

- That the community drinking water safety team be established as soon as possible to raise public awareness and provide residents with the opportunity to voice their concerns regarding drinking water safety.

6.3 Contributions to Literature

As mentioned earlier, this study confirms the multi-dimensional nature of water system capacity. The examination of financial, human resources, institutional, social/political, and technical components permitted the identification of a wide range of flaws in the management of Montreal Lake's drinking water. Although at first glance some of these deficiencies, such as weak linkages, may not appear to impact drinking water safety, this thesis demonstrated the importance of their consideration in an assessment of water system capacity.

The evaluative framework developed in this study may also be useful to research concerning First Nations drinking water management in the future. The combination and modification of the indicators and indicator questions developed by Timmer (2003), and the rating table created by EFC (2005), provides an effective approach of assessing water system capacity. Furthermore, the transparent presentation of the evaluative process in this study ensures that a similar project could be replicated by other researchers in future studies. In particular, the documentation throughout the thesis and appendices provide methodological resources for research in other First Nations communities. Furthermore, with some modifications, the evaluative framework could be used in the capacity assessment of small drinking water systems in general. Specifically, the indicators pertaining uniquely to the First Nations context of drinking water management (operator certification, legislation) could be combined with other indicators (operator diligence, policies) to better reflect the conditions in non-First Nations communities.

6.4 Limitations and Future Research

The results of this research may have been limited by a few factors. In order to meet community and academic needs, constraints were imposed on the time and financial resources available for fieldwork. In conjunction with these limits, Montreal Lake does not offer any accommodation for visitors which further restricted the amount of time that could be spent in the community. Although responses from workshop participants were intended to provide a glimpse of public perception rather than being representative of the community, another public workshop would have greatly benefited this research. A different set of participants and views may have confirmed or broadened the scope of water quality issues in Montreal Lake.

The main limitation of this study relates to the quality of data obtained from the interviews and workshop. The information participants chose to share with me during fieldwork partially depended on how much they trusted me. It is possible that some participants may have confined their responses in a manner that would not draw attention to any water system deficiencies where they, or other participants, may be implicated. Furthermore, as drinking water management in First Nations communities has recently become a highly political issue, it would not be surprising if the responses of participants reflected their position rather than the actual situation in Montreal Lake. The sensitivity of this research was illustrated by the refusal of an interview request for political reasons.

Another limitation of this study pertains to the equal weighting of all capacity indicators. Although previous capacity research has considered indicators to be equivalent, it is very possible that some indicators are more important than others in assessing the capacity of Montreal Lake to provide safe drinking water. For example, having a diligent operator is likely more imperative than having a certified operator who may not adequately perform the required duties. It may also be reasonable to assume that the availability and sufficiency of funding are more significant than the source of funding. Based on my analysis, diligent water system personnel, sufficient funding, and adequate infrastructure appear to be the most critical indicators in the provision of safe drinking water. For small systems in non-First Nations communities, different factors may emerge as more significant, thereby affecting the weighting if this framework were to be applied. Therefore, in the future application of this framework, it may be useful to develop a method of weighing indicators based on the water system being studied to obtain a more accurate assessment of water system capacity.

The safety of drinking water in First Nations communities across Canada is a persistent issue in need of further attention. Therefore, a direction for future research may be to conduct additional capacity assessments in these communities to determine the specific aspects of drinking water management that are in need of improvement. A further direction for research may be to assess the capacity of First Nations communities to provide safe drinking water following the implementation of legislation and source water protection plans. Together, these studies could determine the relative importance of each capacity component in the provision of safe drinking water.

In this study, I set out to further the understanding of First Nations drinking water management by assessing the capacity of Montreal Lake's water system. I determined, like other researchers have to a certain extent in the past, that capacity is improving. However, there is room for improvement. Looking towards the future, the enhancement of linkages and the development of a cistern maintenance program are two key areas that would significantly increase drinking water safety within the community.

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Appendix 1

Guiding Questions for Interviews

A. Montreal Lake – Specific Questions

1. Describe Montreal Lake's Drinking Water System:
1a) Source Water
1b) Treatment
1c) Maintenance
1d) Monitoring
1e) How many homes have water piped in?
1f) How many homes are delivered water? Is amount of trucks sufficient?
1g) Are residents responsible for maintenance of cisterns?
1h) How often in the Montreal Lake Water Treatment Plant inspected?
1i) What is the status of the treatment plant?

B. Financial Capacity

2. Does the water utility maintain an annual fiscal surplus?
3. Do you seek funding from external sources?
4. Is anyone on staff dedicated to seeking external resources for water system projects?
5. Do you work together with other organizations to attract new funds for water system projects?
6. Does the cost of water, charged to users, reflect the cost of providing clean water?
7. Is water use metered throughout the community?
8. Is funding available for water system projects?
9. Where does funding come from?
10. Are funds available for long-term projects?
11. What kind of financial support has INAC provided the community in the past?
12. Is INAC currently financing any water projects within the community?
13. What kind of financial support has Health Canada provided the community in the past?

C. Human Resources Capacity

14. How many people are employed (full or part time) by the water utility?
15. How many employees in your organization are dedicated to water management?
16. What level of education/training is required to work in the water utility?
17. Do all staff members meet those requirements?
18. What opportunities do staff members in your organization have to upgrade their education/training in regard to water management?
19. Do you have water experts on staff or do you have access to experts from other organizations/senior levels of government to deal with surface and ground water quality issues? (hydrologists, water resources technicians, groundwater specialists)

D. Institutional and Social/Political Capacity

20. Who (which organization) provides leadership for water management within the Montreal Lake region?
21. Do you work with senior levels of government for water quality protection?
22. Do you work with other local governments in the watershed to protect drinking water quality?
23. Is your organization involved in any partnerships with nongovernmental organizations that are focused on water management within the watershed?
24. Is the community affiliated with any Aboriginal organizations or tribal councils that assist in drinking water management?
25. If yes, describe the role of this organization.
26. Describe the community's relationship with INAC.
27. How does INAC assist the community in managing the provision of safe drinking water?
28. Describe the community's relationship with Health Canada.
29. How does Health Canada assist the community in the provision of safe drinking water?
30. Is Health Canada currently involved in the testing of the community's water quality?
31. If yes, how often does Health Canada test the community's water?
32. Have emergency plans been developed to guide the community's response to low water quality situations?
33. If (when) a drinking water problem arises, what individuals and organizations (government, non-government, Aboriginal) get involved?
34. What role does each one play in restoring safe drinking water for the community?
35. Is there community support for watershed protection?
36. Have education programs been developed to increase public awareness of water quality issues within the watershed?
37. Have programs been developed to encourage community participation in water supply protection?

F. Technical Capacity

38. Does the quality of drinking water meet federal drinking water standards established in the *Guidelines for Canadian Drinking Water Quality* published by Health Canada?
39. Is source water quality monitored? How often?
40. Do you have access to watershed data that you need to manage source water?
41. Do you know how much water is available in the watershed?
42. Have potential contaminant sources in the watershed been identified?
43. What are these contaminant sources?
44. Is there an inventory of these sources?
45. Is there a plan to manage these sources?
46. Has drinking water ever been found to be below drinking water standards established by Health Canada in the *Guidelines for Canadian Drinking Water Quality*?
47. What procedures are used to treat water?

48. Has a boil-water advisory ever been issued for the community?

If yes:

49a. When did the most recent boil-water advisory take place?

49b. What was the cause?

49c. What was the duration?

49d. Who issued the advisory?

49e. How did community members respond?

49f. What was done to address the issue?

49g. Were any individuals, agencies, or organizations from outside the community involved?

50. When water is shut down in the community, how long does this last and what is usually the cause?

51. Are there any future infrastructure upgrades planned for the community's water system?

52. Are there any infrastructure upgrades or improvements that need to be addressed

53. What about population growth in the community; the future subdivision will require more infrastructure. Is the treatment plant designed for the amount of residents in the community and the amount of growth community can expect?

54. Does the community have any other sources of technical and financial assistance for the provision of safe drinking water?

G. General

55. Do you feel there are any concerns with the drinking water system? Any that you feel need to be addressed?

56. Are there any concerns with the lagoon and wastewater system?

57. Are there any issues or areas that could be improved in the current management system.

58. What do you think is the key barrier, if present, to a coordinated approach to a safe drinking water supply in this community?

59. Looking towards the future (climate change, changes in policy) do you have any concerns about the ability of the community of Montreal Lake to provide safe drinking water?

Appendix 2

Guiding Questions for Community Workshops

A. The Past as a Means to Understand the Current Context

1. What major changes have occurred within your community over the past 25-50 years and what prompted these changes?
2. How have these changes affected your community, especially overall community well-being?
3. How has your community coped with and if necessary adapted to these changes?
4. What strategies worked best in your community to deal with the changes and move ahead?

B. Looking to the Future

1. What are the prospects for your community over the next 25-50 years?
2. What are the long-term prospects for community well-being over the next 25-50 years?
3. How do you think your community will look in 25-50 years from now?
4. What are the barriers to the future development of your community?
5. What are the major planning initiatives and policies (local, provincial and federal) that will effect and influence the development of your community over the next 25-50 years

C. Community Development and Climate Sensitivities

1. Do you feel that climate has changed in your region over the past 25-50 years? If so, how?
2. Have these past climate changes impacted your community and how?
3. What aspects of your community's future development plans are/are not sensitive to future climate changes?

D. Future Scenarios and Community Development

Communities are dynamic and have been responding to multiple stressors, this is not new. We do not know future conditions with certainty so we will ask you to consider 3 possible futures. Please consider the following 4 scenarios for future development and climate change in your region and for each scenario, consider:

1. Would the scenario alter expected developments and overall community well-being in your community and how?
2. What aspects of the scenario would trigger the need to alter future development plans?
3. What barriers might hinder your community's capacity to adapt under this scenario?
4. What strategies would you employ to adapt to the future (either to reduce negative effects or capitalize on emerging opportunities?

E. Montreal Lake Drinking Water

1. What is your impression of drinking water in the community?
2. Do you have any concerns in regards to the community's current and future state(s) of the community's drinking water system?

Appendix 3

Case Study Documents

Associated Engineering. Undated. Projects: Lagoon Expansion Montreal Lake Cree Nation, Saskatchewan. http://www.ae.ca/projects/wstwtr/Montreal%20Lake%20Lagoon%20Exp.pdf

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Appendix 4

Indicator Questions

Indicator	Indicator/Research Questions
Financial Capacity	
Funding is available for operation and maintenance	a. Is funding available for operation and maintenance (where does funding come from)?
Funding is sufficient for operation and maintenance	a. Is funding sufficient to cover the full extent of operation and maintenance costs?
Funding is available for infrastructure and water system projects	a. Is funding available for infrastructure and water system projects (where does funding come from)?
Funding for water system is stable	a. Is funding available for several consecutive years?
Funds are generated within the community	a. Are funds generated partially or entirely within the community?
Funds are generated outside the community	a. Are funds generated partially or entirely outside the community (where does the funding come from)?
Water rates for customers reflect the cost of providing drinking water (treatment, distribution, maintenance)	a. Does the cost of water, charged to users, reflect the cost of providing clean water? b. Is water metered throughout the community?
Funding surpluses are saved for future water system requirements	a. Are funding surpluses saved from years where water system upgrades are not required so that they may be used in years where upgrades are required?
Human Resources Capacity	
Departments responsible for providing drinking water have a sufficient number of employees dedicated to water management	a. Is the amount of employees dedicated to water management sufficient to undertake the management activities required?
Departments responsible for providing drinking water have diligent personnel to adequately operate and maintain the system	a. Are water treatment plant operators diligent in their operation and maintenance activities?
Departments responsible for providing drinking water have certified personnel to adequately operate and maintain the system	a. Are water treatment plant operators certified to the level of Montreal Lake's water treatment plant?
Departments responsible for providing drinking water have access	a. Does the community have access to support on operation and maintenance issues from

to individuals with the necessary skills and training to manage drinking water	professionals? (health officers, utilities trainer) b. Where are these professionals based?
Departments responsible for providing drinking water have access to individuals with the expertise needed to undertake technical activities related to drinking water quality	a. Does the community have access to experts from government/tribal agencies to deal with water quality and water system issues? (water resource technicians, engineers) b. Where are these experts based?
Education and training opportunities are available to staff members from departments involved in providing drinking water	a. What opportunities do staff water system personnel have to upgrade their education/training in regard to water treatment plant operation?
Education and training opportunities are regularly taken up by staff members from departments involved in providing drinking water	a. Are education and training opportunities regularly taken up by water system personnel to upgrade their education/training?
Institutional Capacity	
Federal legislation provides guidance for the provision of safe drinking water in the community	a. Does federal legislation exist to provide regulation of drinking water provision in the community?
Federal policies provide guidance for the provision of safe drinking water in the community	a. Do documents produced by INAC and Health Canada influence the provision of safe drinking water in the community?
Federal legislation provides guidance for the roles and responsibilities of players involved in the provision of safe drinking water	a. Are the roles and responsibilities of those involved in drinking water provision bound by federal legislation?
Federal policies provide guidance for the roles and responsibilities of players involved in the provision of safe drinking water in the community	a. Do documents produced by INAC and Health Canada delineate the roles and responsibilities of those involved in the provision of drinking water in the community?
Plans have been developed to guide community actions for regular provision of drinking water	a. Have plans been developed at the local level to guide community actions for regular provision of drinking water?
Plans have been developed to guide community actions during water quality emergencies	a. Have emergency plans been developed to guide the community's response to low water quality situations?
A source water protection plan has been developed	a. Has a plan been developed to protect the community's drinking water supply?
Social / Political Capacity	
Clear leadership (clear delineation of responsibilities) for the provision of safe drinking water in the community	a. Who provides leadership for the various aspects of drinking water management in the community?

exists	
Active linkages between community and tribal council departments exist (vertical linkages)	a. Do Montreal Lake and the PAGC have a working relationship where information and resources, when needed, are easily and frequently exchanged?
Active linkages between community and federal government departments exist (vertical linkages)	a. Do Montreal Lake and INAC/Health Canada have a working relationship where information and resources, when needed, are easily and frequently exchanged?
Active linkages between tribal council and federal government departments exist (vertical linkages)	a. Do the PAGC and INAC/Health Canada have a working relationship where information and resources, when needed, are easily and frequently exchanged?
Active linkages between community departments and community councils exists (horizontal linkages)	a. Do water treatment plant operators and Band councils have a working relationship where information and resources, when needed, are easily and frequently exchanged?
Community awareness and concern for water quality management has been developed	a. Is there community interest in water quality issues? b. Have education programs been developed to increase public awareness of water quality issues within the community?
Community members are regularly involved in decisions pertaining to the management of drinking water	a. Have programs been developed to encourage community participation in drinking water management? b. Do community members have an influence in the management of drinking water within the community?
Technical Capacity	
Community drinking water quality currently meets drinking water standards	a. Does the quality of drinking water provided to the community's residents meet the federal standards established in the *Guidelines for Canadian Drinking Water Quality* published by Health Canada?
Community drinking water quality is monitored regularly (daily tests)	a. Are the daily drinking water tests (bacteriological, chlorine residual, turbidity) regularly conducted?
Community drinking water quality is monitored regularly (weekly and quarterly tests)	a. Are the weekly and quarterly drinking water tests (distribution systems, trihalomethanes) regularly conducted?
Community drinking water quality is monitored regularly (annual tests)	a. Are the annual drinking water tests (full range of contaminants) regularly conducted?
Physical infrastructure is adequate to produce safe drinking water for the community's residents	a. Is the Montreal Lake treatment plant capable of producing safe drinking water?

Physical infrastructure is adequate to distribute safe drinking water to the community's residents	a. Is the physical infrastructure in the community capable of distributing safe drinking water from the treatment plant to the taps of homes?
Source water adequacy in terms quantity	a. Is Montreal Lake large enough to provide the community with a reliable source of water?
Source water adequacy in terms of quality	a. Is Montreal Lake a suitable raw water source for drinking water?
Potential water supply contaminant sources (point and non-point) have been identified	a. Have potential contaminant sources in the watershed been identified (human and animal wastes, forestry, fishing, recreational use of lake, industry)?

Appendix 5

Explanation of Capacity Indicators Rating Table

Financial Capacity

a) Funding is available for operation and maintenance
b) Funding is sufficient for operation and maintenance
c) Funding is available for infrastructure and water system projects

The components of financial capacity listed above as letters (a), (b) and (c) are rated according to the following criteria:

A minus (-) rating indicates that funding is not currently available/sufficient for this purpose.
A plus-minus (+/-) rating indicates that funding is currently available/sufficient for this purpose but is not sufficient to cover total expenses.
A plus (+) rating indicates that funding is currently available/sufficient for this purpose and is sufficient to cover total expenses.
An arrow (→) rating indicates that funding is currently available/sufficient for this purpose, is sufficient to cover total expenses, and is expected to be available in the future to cover total expenses.

d) Funding for water system is stable

The component of financial capacity listed as letter (d) is rated according to the following criteria:

A minus (-) rating indicates that funding is not currently stable.
A plus-minus (+/-) rating indicates that some funding is currently stable.
A plus (+) rating indicates that funding is currently stable.
An arrow (→) rating indicates that funding is currently stable and is expected to be in the future.

e) Funds are generated within the community
f) Funds are generated outside the community

The components of financial capacity listed above as letters (e) and (f) are rated according to the following criteria:

A minus (-) rating indicates that funds are currently not generated in this region.
A plus-minus (+/-) rating indicates that some of the funds are currently generated in this region.
A plus (+) rating indicates that funds are currently generated in this region.

An arrow (→) rating indicates that funds are currently generated in this region and are expected to be in the future.

g) Water rates for customers reflect the full cost of providing drinking water (treatment, distribution, maintenance)

The final component of financial capacity listed above as letter (h) is rated according to the following criteria:

A minus (-) rating indicates that water rates do not currently reflect the full cost of providing drinking water.
A plus-minus (+/-) rating indicates that water rates currently reflect some of the full cost of providing drinking water.
A plus (+) rating indicates that water rates currently reflect the full cost of providing drinking water.
An arrow (→) rating indicates that water rates currently reflect the full cost of providing drinking water and are expected to do so in the future.

h) Funding surpluses are saved for future water system requirements

The component of financial capacity listed above as letter (g) is rated according to the following criteria:

A minus (-) rating indicates that funding surpluses are not currently saved for future requirements.
A plus-minus (+/-) rating indicates that some funding surpluses are currently saved for future requirements.
A plus (+) rating indicates that funding surpluses are currently saved for future requirements.
An arrow (→) rating indicates that funding surpluses are currently saved for future requirements and are expected to be in the future.

Human Resources Capacity

a) Departments responsible for providing drinking water have a sufficient number of employees dedicated to water management

A minus (-) rating indicates that departments do not have a sufficient number of employees dedicated to water management.
A plus-minus (+/-) rating indicates that departments somewhat have a sufficient number of employees dedicated to water management.
A plus (+) rating indicates that employees are dedicated to water management.

b) **Departments responsible for providing drinking water have diligent personnel to adequately operate and maintain the system**
c) **Departments responsible for providing drinking water have certified personnel to adequately operate and maintain the system**

A minus (-) rating indicates that departments do not have diligent/certified personnel to adequately operate and maintain the system.
A plus-minus (+/-) rating indicates that departments somewhat have diligent/certified personnel to adequately operate and maintain the system.
A plus (+) rating indicates that departments have diligent/certified personnel to adequately operate and maintain the system. .

d) **Departments responsible for providing drinking water have access to individuals with the necessary skills and training to manage drinking water**
e) **Departments responsible for providing drinking water have access to individuals with the expertise needed to undertake technical activities related to drinking water quality**

A minus (-) rating indicates that there is no access to these individuals.
A plus-minus (+/-) rating indicates that there is some access to these individuals.
A plus (+) rating indicates that there is access to these individuals.

f) **Education and training opportunities are available to staff members from departments involved in providing drinking water**

A minus (-) rating indicates that education and training opportunities are not available.
A plus-minus (+/-) rating indicates that some education and training opportunities are available.
A plus (+) rating indicates that education and training opportunities are available.

g) **Education and training opportunities are regularly taken up by staff members from departments involved in providing drinking water**

A minus (-) rating indicates that education and training opportunities are not regularly taken up by staff members.
A plus-minus (+/-) rating indicates that some education and training opportunities are regularly taken up by staff members.
A plus (+) rating indicates that education and training opportunities are regularly taken up by staff members.

Institutional Capacity

a) **Federal legislation provides guidance for the provision of safe drinking water in the community**

b) Federal policies provide guidance for the provision of safe drinking water in the community
c) Federal legislation provides guidance for the roles and responsibilities of players involved in the provision of safe drinking water in the community
d) Federal policies provide guidance for the roles and responsibilities of players involved in the provision of safe drinking water in the community

A minus (-) rating indicates that federal legislation/policies do not provide guidance for this purpose.
A plus-minus (+/-) rating indicates that federal legislation/policies somewhat provide guidance for this purpose.
A plus (+) rating indicates that federal legislation/policies provide guidance for this purpose.
An arrow (→) rating indicates that federal legislation/policies provide guidance for this purpose and are expected to do so in the future.

e) Plans have been developed to guide community actions for regular provision of drinking water
f) Plans have been developed to guide community actions during water quality emergencies

A minus (-) rating indicates that plans have not been developed to guide community actions for this purpose.
A plus-minus (+/-) rating indicates that some plans have been developed to guide community actions for this purpose.
A plus (+) rating indicates that plans have been developed to guide community actions for this purpose.
An arrow (→) rating indicates that plans have been developed to guide community actions for this purpose and are expected to do so in the future.

g) A source water protection plan has been developed

A minus (-) rating indicates that a plan has not been developed to protect the community's source of drinking water.
A plus-minus (+/-) rating indicates that part of a plan has been developed to protect the community's source of drinking water.
A plus (+) rating indicates that a plan has been developed to protect the community's source of drinking water.
An arrow (→) rating indicates that a plan has been developed to protect the community's source of drinking water and is expected to do so in the future.

Social / Political Capacity

a) **Clear leadership for the provision of safe drinking water in the community exists**

A minus (-) rating indicates that clear leadership does not exist.
A plus-minus (+/-) rating indicates that some leadership exists.
A plus (+) rating indicates that clear leadership exists.

b) **Active linkages between community and tribal council departments exist (vertical linkages)**
c) **Active linkages between community and federal government departments exist (vertical linkages)**
d) **Active linkages between tribal council and federal government departments exist (vertical linkages)**
e) **Active linkages between community departments and community councils exists (horizontal linkages)**

A minus (-) rating indicates that active linkages do not exist.
A plus-minus (+/-) rating indicates that some active linkages exist.
A plus (+) rating indicates that active linkages exist.

f) **Community awareness and concern for water quality management has been developed**

A minus (-) rating indicates that community awareness and concern has not been developed.
A plus-minus (+/-) rating indicates that some community awareness and concern has been developed.
A plus (+) rating indicates that community awareness and concern has been developed.

g) **Community members are regularly involved in decisions pertaining to the management of drinking water**

A minus (-) rating indicates that community members are not involved in decisions.
A plus-minus (+/-) rating indicates that community members are somewhat involved in decisions.
A plus (+) rating indicates that community members are involved in decisions.

Technical Capacity (Piped and Truck Haul Distribution Systems)

a) **Community drinking water quality currently meets drinking water standards**

A minus (-) rating indicates that water quality does not currently meet drinking water standards.
A plus-minus (+/-) rating indicates that water quality currently meets some drinking water standard.
A plus (+) rating indicates that water quality currently meets drinking water standards.

b) Community drinking water quality is monitored regularly (daily tests)
c) Community drinking water quality is monitored regularly (weekly and quarterly tests)
d) Community drinking water quality is monitored regularly (annual tests)

A minus (-) rating indicates that water quality is not monitored regularly.
A plus-minus (+/-) rating indicates that water quality is monitored somewhat regularly (all tests may not be conducted).
A plus (+) rating indicates that water quality is monitored regularly.

e) Physical infrastructure is adequate to produce safe drinking water for the community's residents
f) Physical infrastructure is adequate to distribute safe drinking water to the community's residents

A minus (-) rating indicates that physical infrastructure is not adequate.
A plus-minus (+/-) rating indicates that some physical infrastructure is adequate.
A plus (+) rating indicates that physical infrastructure is adequate.
An arrow (→) rating indicates that physical infrastructure is adequate and is expected to be in the future.

g) Source water adequacy in terms quantity
h) Source water adequacy in terms of quality

A minus (-) rating indicates that source water is not adequate in this parameter.
A plus-minus (+/-) rating indicates that source water is somewhat adequate in this parameter.
A plus (+) rating indicates that source water is adequate in this parameter.

i) Potential water supply contaminant sources (point and non-point) have been identified

A minus (-) rating indicates that potential water supply contaminant sources have not been identified.
A plus-minus (+/-) rating indicates that some potential water supply contaminant sources have been identified.

A plus (+) rating indicates that some potential water supply contaminant sources have been identified.

An arrow (→) rating indicates that source water is adequate in this parameter and is expected to be in the future.